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J. W. RICHARDS, PH. D.....*President*
E. F. ROEBER, PH. D.....*Editor and Secretary*
C. E. WHITTLESEY.....*Treasurer*

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CONTENTS.

EDITORIAL:
A Symposium on the Electrometallurgy of Iron and Steel..... 143
Bakelite 144
Production Costs in the Steel Trade..... 144
"Social Engineering"..... 145
Program of Niagara Meeting of American Electrochemical Society.. 146
An Extravaganza Night at the Chemists' Club..... 146
Electric Pig-Iron Plant in Norway..... 146
Electric Iron-Ore Reduction in Sweden..... 146
New York City Proposed for the 1910 International Congress of Applied Chemistry..... 146
New York Section American Electrochemical Society..... 147
Nitric Acid from Air..... 147
Iron and Steel Market..... 147
CORRESPONDENCE:
The Electrolytic Reduction of Aluminium as a Laboratory Experiment. By Richard Seligman..... 148
Steel from Ore in the Electric Furnace. By Francis A. J. Fitz Gerald 148
Schweitzer Celebration..... 149
Corrosion of Zinc-plated Iron Wire and Corrosion of Tubes and Shells of Steam Boilers. By W. H. Walker..... 150
Autogenous Welding of Aluminium. By M. U. Schoop..... 151
Reduction of Iron Ore in the Electric Furnace. By R. Catani..... 153
The Production of Pig Iron in the Electric Furnace and the Industrial Utilization of Pyrite Ash. F. E. Carano..... 155
The Electrochemistry of the Solution of Gold in Potassium Cyanide.. 156
The Use of Producer Gas in Chemical and Metallurgical Industries. By Dr. Oskar Nagel..... 158
Electric and Fuel Furnaces. By F. Louvrier..... 160
Physical Chemistry and Electrochemistry at the College of the City of New York. By Leo F. Guttman..... 162
NOTES ON ELECTROCHEMISTRY AND METALLURGY IN GREAT BRITAIN.... 164
Shipment of Calcium Carbide..... 166
ANALYSIS OF CURRENT ELECTROCHEMICAL PATENTS..... 167
SYNOPSIS OF PERIODICAL LITERATURE..... 168
RECENT METALLURGICAL PATENTS..... 169
Electric Furnace Leads..... 170
The Use of Pyrometers in Various Industries..... 170
Induction Furnaces..... 171
Collecting Precious Metal Dust..... 173
Electrically Heated Incubator for Laboratories..... 173
One-half Ton Hoist..... 174
Washing and Coking of Coals..... 174
Increase in Use of Wood Preservatives..... 175
Engineering Books in Public Libraries..... 175
NOTES 175
DIGEST OF U. S. PATENTS (Electric Furnaces)..... 176
NEW BOOKS..... 177
BOOK REVIEWS..... 178

A Symposium on the Electrometallurgy of Iron and Steel.

At the psychological moment a symposium on the electrometallurgy of iron and steel has been arranged for the first day of the May meeting of the American Electrochemical Society at Niagara Falls (the preliminary program being printed on page 146). In several steel plants in this country—and abroad even to a larger extent—the crucible process has been replaced by the electric furnace for the commercial production of high-grade special steels of crucible-steel quality. Further, the U. S. Steel Corporation has just adopted the electric furnace as an accessory to the Bessemer converter and open hearth, to produce large-tonnage steel products of greatly improved quality, especially rails and wire. Now, even the production of pig iron from ore in the electric furnace appears to pass from the experimental stage to commercial practice in two countries where the conditions appear especially favorable. As mentioned on page 146, a commercial electric-furnace plant for making pig iron and steel is to be started in Norway, and it is rumored that a large plant for the same purpose is to be erected at a favorable place in Canada as a result of the trip which Dr. Haanel recently made to Sweden to report to the Canadian Government on the furnace of the Elektrometall Company, Ludwika. The whole iron and steel industry is, therefore, just now immensely interested in the possibilities and actual accomplishments of the electric furnace. Much has been written and printed on this subject in recent years, and it has been the privilege of this journal to be the pioneer journalistic exponent of this new electrometallurgical industry, and to publish authoritative articles contributed to our columns by the leading electrometallurgists of iron and steel in all countries. But at the Niagara meeting of the American Electrochemical Society it will be for the first time that the whole subject is to be presented and discussed before a national engineering and scientific society.

* * *

While Dr. Héroult, of France, will probably not be present himself, a paper on the Héroult furnace and process will be presented by Mr. R. Turnbull, one of Dr. Héroult's chief engineers. It is the Héroult furnace that has just been adopted by the U. S. Corporation, and at the beginning of this year there were already in operation or in course of erection 19 Héroult furnaces with an aggregate charging capacity of 30 tons, and five Héroult furnaces the capacity of which had not yet been definitely decided. This does not include, of course, the new 15-ton Héroult furnaces of the Steel Corporation. Major Ernesto Stassano, the distinguished Italian pioneer of the electric iron and steel furnace, will himself be present at the Niagara meeting; this will be his first visit to this country. It will be remembered that Dr. Hans Goldschmidt's report, made in 1902 to the German Patent Office on the Stassano process, was the first official document which attracted attention

to these early experiments and changed ridicule into consideration. At the beginning of 1909 there were 11 Stassano furnaces in operation or course of erection with an aggregate charging capacity of eight tons. A paper by Dr. F. A. Kjellin, the Swedish pioneer of the induction furnace, will cover the latest developments in the simple induction furnace and the Roechling-Rodenhauser combination furnace; of both types together there were in operation or in course of erection at the beginning of this year 20 furnaces with an aggregate charging capacity of 23 tons; it may be remembered that in an 8-ton Roechling-Rodenhauser furnace considerable quantities of steel have been made for rails of the Prussian railways. A paper by M. Girod, of France, will deal chiefly with his large and very interesting new electric steel plant, an illustrated description of which appeared in our January issue, page 9. At the beginning of this year there were in operation or in course of erection eight Girod furnaces with an aggregate charging capacity of 15 tons. Papers are also expected from M. Keller and M. Gin, two French metallurgists who have contributed much to the electrometallurgy of steel. Further, Mr. FitzGerald will give an analysis of the Lash process to explain more clearly what the Lash process is and why it may be of interest in the electric furnace. Finally, it is hoped that Dr. Haanel, Director of Mines of Canada, will not only attend the meeting, but present a paper embodying the results of his latest researches in this field in which he has done such important and effective pioneer work. To sum up, it will be seen that the program is thoroughly representative of the whole new industry, and we hope sincerely that the meeting will be attended by many practical steel men to participate in the discussion. For, as we have repeatedly pointed out, further progress depends chiefly on sound and healthy coöperation between electric-furnace engineers and practical steel men.

Bakelite.

In coining the name "bakelite" for the latest product of his inventive genius, Dr. Baekeland must have been conscious of the friendly jokes he was inviting. But he must also have felt that the new stuff with its remarkable properties was worthy to bring his name down to future generations. Since we published Dr. Baekeland's paper in our last issue, so many inquiries have been received at this office from most different quarters that it is hardly an exaggeration to say that bakelite is the most talked-of chemical invention of recent years. That new interesting products may be obtained by reactions between formaldehyde and phenolic bodies has long been known, but Dr. Baekeland brought order into the chaos. His invention was not made at haphazard, but is the result of a systematic study of the way in which the results vary with the conditions under which the reaction is carried out. His method of preventing dissociation with formation of a porous solid, simply by working under pressure in a "bakelizer," is as simple as ingenious. The existence of an intermediate product *B* between the initial condensation product *A* and the final product *C* seems at first to complicate matters, but is really of immense importance, as it shortens the time of the molding operation. The molds are not needed for the whole change from *A* to *C*, but only for *A* to *B* or for *B* to *C*. It is very interesting to know that the synthesis accomplished by Dr. Baekeland in the laboratory seems to have a decided similarity to some intricate biological processes that take place in the cells of certain plants. Dr. Baekeland's new paper, to be presented before the Electrochemical Society in May, will certainly be awaited with great interest. We defer further comment until then.

Production Costs in the Steel Trade.

At the tariff hearings in November and December statements were made on behalf of the steel trade to the effect that there had been an enormous increase in the cost of production in the past 10 years. There was criticism of some of these statements in most quarters to the effect that they drew somewhat too striking a picture of the changes which had occurred. There is no doubt, of course, that the manufacturers endeavored to put their best foot forward, and there is no doubt, either, that they succeeded, so far as concerns the spreading of statements upon the records of the Ways and Means Committee. It appears, however, that they did not make so forcible a record upon the tariff bill which the committee produced. The committee made fairly radical reductions in the duties and showed a remarkable lack of apprehension of details by failing to classify merchant steel bars as they should be, as a finished product, but instead keeping them with billets and reducing the rate from $6.72 a gross ton to $3.92. It is not our purpose, however, to discuss the tariff bill. What we wish rather to point out is that since the general reductions in finished steel prices, dating from the decision on Feb. 18, to let the market seek a new level, the iron and steel trade has come to realize that there is somewhat more in the matter of increased costs than it realized last November.

* * *

It will be recalled that the lowest prices for finished steel products in the history of the industry were made in 1897 and 1898, principally in the former year. There was an increase of more than 2,000,000 tons, more than 20 per cent, in the production of pig iron from 1897 to 1898, although 1897 had been a record year, but the increase was not sufficient to engage all existing capacity, and the industry was still down on hard pan. In 1899, however, there came, in the market, a remarkable boom. The memory it left in the minds of those who participated was chiefly that of a remarkable increase in demand and production, with prices soaring sky-high. As a matter of fact, the increase in tonnage production from 1898 to 1899 was less than that from 1897 to 1898, and the percentage, of course, showed a still larger decrease, but the market found an enormous difference in the conditions, the difference between an insufficient demand, relative to capacity, and a slight excess of demand. The low prices of 1897-8, not the lowest prices done in any instance, but the lowest prices generally recognized in the market for any length of time in either of those years, were about as follows at Pittsburgh: Billets, $14; steel bars, 90 cents a hundred; plates and shapes, 95 cents a hundred; rails, $16; plain wire, $1.25 a hundred. Bessemer pig iron was sold at $8.75, valley furnace, and foundry and forge iron at slightly lower prices.

* * *

The boom of 1899 brought Bessemer pig iron to $24 at valley furnace, and Bessemer billets on round tonnages to $38, while

occasional prompt lots sold up to $44. Plates, shapes and bars sold at about 3 cents a pound for quick delivery. Rails were cheerfully advanced to $35, for the season of 1900, although the railroads did not take hold to any extent at that price. The boom of 1899 started a career of extravagance in the iron and steel trade, and except for occasional savings in new mechanical devices and improved processes, costs have been advancing almost steadily for 10 years. The depression of 1908 capped the climax, because the spirit of the times, not simply in the steel trade, but in most lines of endeavor, was to maintain prices of labor and commodities generally. With reduced tonnages and mixed specifications, and no offset by lower rates at any point, the steel trade found costs per ton of output higher in 1908 than in 1907.

* * *

It has not been alone at the works that costs advanced in the 10-year period. The railroads have advanced freight rates and the cost of assembling the large tonnage of raw material for the blast furnace has thereby been greatly increased. In the 10 years 1898 to 1907, inclusive, the United States made 181,470,757 tons of pig iron, the great bulk of which was made from Lake Superior ore, and the best ores in the region have been largely exhausted. The ores now mined are gained at greater cost in actual effort expended and are leaner, involving the assembling of a larger tonnage of ore, coke and limestone per ton of pig iron produced. These are actual material advances, and besides them there have been written into transactions other increases in cost. It is not much more than 10 years ago that Mesabi range leases, at the Minnesota State royalty of 25 cents, went begging, while to-day there are leases at close to a dollar a ton involving much less desirable ores. If prices lately made on finished steel products, $1.20 per 100 lb. on bars and $1.30 per 100 lb. on plates and shapes, are compared with the record low prices of 1897-8, they appear high, showing an advance of 30 to 35 cents per 100 lb., about $7.25 per gross ton. Relative to bare costs of manufacture, including wages and freights paid and materials consumed, the actual advance is very much less than this, while, putting the minerals at the values which have lately been assigned them, there has been practically no advance at all. In other words, at these new prices the steel trade is doing not a great deal more than obtaining returns to meet its increased costs and the values it has written upon its minerals.

* * *

The costs will, and must be, reduced, although the tendency to reduce wages, an unpleasant necessity, of course, does not seem to be as marked as it should be. In some branches there has been more disposition to reduce salaries, and this is not as it should be. The steel industry is destined to undergo great changes in the next few years, and will require more brains than it has lately. The readjustment will necessarily be slow. Comparisons with the low prices of 1897-8 must take into account the fact that it required four years of adversity, after the panic of 1893, to develop the low costs on which those prices were based. The trade needed tonnage as badly in 1894 and 1896 as it did in 1897, and much more badly than in 1898, but it was not then in position to make the low prices. The work was not done in a year, and cannot now be done in a year.

"Social Engineering."

Such is the title of a very interesting new book which will be found reviewed in the "Book Reviews" of this number. The expression gives us some reflections. All Americans are either employers or employed. The relations between these are of vital interest to everybody. Some, in fact, many of us, belong to both classes. It is well worth considering carefully and trying judiciously to improve these vital relations. As employees, our duty and best interest lies in giving our employers *more* than they pay us for, in rendering abundant and willing service. If I do one dollar's worth of work and my employer pays me one dollar, we are quits; value has been received and the transaction is closed. But if I return him more than one dollar's worth of service, the transaction is not closed; the extra service is not paid for at once in coin of the realm, but is stored up as obligation, to be paid later in the form of consideration and promotion. Let our younger employees in particular remember this, that promotion is the wage and reward of superabundant, unpaid-for service, and that this compensation is as sure to come as the usual monthly check or Saturday-night envelope. It comes to him who waits and who "hustles while he waits."

* * *

About employers, however, we wish to speak more fully. The average wage earner is underpaid. The terrible, impersonal law of supply and demand applies to labor and wages, and the comfort and well-being of the majority of mankind are at its mercy, however pitiless that may be. And herein lies the first principle of humanizing treatment of employees, namely, to moderate as far as possible the mercilessness of this law. Only humanitarianism, the brotherly instinct, can do this; love of gain works the other way. What should be the fair, proper wage to pay our employees? What they are forced to work for, by the law of supply and demand, the exigencies of daily bread, or shall it be "what we can afford"? And herein lies the true brotherly spirit, to compensate your employee not according to his necessity, but according to your ability. Let us think this out. Is there any obligation to do this? No legal obligation; only the moral force of the word "ought."

* * *

But will employees appreciate this new principle, will they respond to its kindly motives, will they really be bettered by it? Who can doubt it? Our working classes feel too often the sharp prod of necessity; they all too often need more and better food, clothing, shelter, sanitation, amusements, education, moral uplift. All of these are made possible by higher wages and considerate treatment by employers. The employer must feel that, of all classes of men, he is particularly his brother's keeper. But what if such altruistic, liberal treatment is not appreciated, what if it is abused, scorned, the kindly attitude misconstrued and ingratitude returned for thoughtful consideration? Well, that does not change one iota the moral obligation of the employer. What is done for goodness' sake must be done independent of thought of reward, or appreciation, or whatever may result. Give your employees all that you can afford to give them, wages, time, consideration, brotherly sympathy—and have your conscience commend.

Program of Niagara Meeting of American Electrochemical Society.

The annual meeting of the American Electrochemical Society, which will be held in Niagara Falls, Canada, on Thursday, Friday and Saturday, May 6, 7 and 8, is already attracting the widest attention.

A special feature of particular interest will be a symposium of papers on the electrometallurgy of iron and steel. The whole first day (May 6) will be devoted to this subject. The papers will be presented in the morning, and the discussion will take place in the afternoon. There are papers promised by Dr. Eugene Haanel, Dr. Paul Heroult, M. Paul Girod, Dr. F. A. Kjellin, M. C. A. Keller, M. Gustave Gin, Mr. R. Turnbull, Capt. Ernesto Stassano and Mr. F. A. J. FitzGerald. We comment on this feature of the program on our editorial pages.

Other fields of electrochemistry will, however, not be neglected. Among the papers which have been promised for presentation on Friday and Saturday are the following:

"Electrochemical Methods of Soil Analysis," by Dr. F. K. Cameron.

"The Chemical Electrolysis of Acetates," by Prof. W. D. Bancroft.

"Addition Reagents in Plating Baths," by Dr. E. F. Kern.

"The Electrolytic Deposition of Platinum," by Mr. McCaughey.

"On the Deposition of Some Metals from Acetone Solution," by Dr. H. E. Patten and Mr. W. R. Mott.

"A New Radiation Pyrometer," by Mr. Chas. E. Foster.

"The Automatic Registration of Temperatures," by Dr. E. F. Northrup.

"A New Type of Ammeter for the Accurate Measurement of Alternating Currents above 1000 Amperes," by Dr. E. F. Northrup.

"Furnace Electrode Losses," by Mr. C. A. Hansen.

"The Relative Efficiency of the Arc and Resistance Furnaces for the Manufacture of Calcium Carbide," by Prof. S. A. Tucker, Mr. W. A. Alexander and Mr. H. K. Hudson.

"The Deposition of Aluminium from Aqueous Solutions with the Use of a Rotating Cathode," by Prof. S. A. Tucker and Mr. E. G. Thomssen.

"The Uses of Bakelite for Electrical and Electrochemical Purposes," by Dr. L. H. Baekeland.

"The Probable Electrical Nature of Chemical Affinity," by Prof. A. H. Patterson.

"Standard Cells," by Dr. F. A. Wolff.

On the evening of Thursday the address of the retiring president will be delivered by Dr. Edward G. Acheson, president of the International Acheson Graphite Co.

Arrangements will be made at the Clifton Hotel for exhibits of electrochemical and electrometallurgical products, particularly iron and steel produced in the electric furnace. Members may submit exhibits. Arrangements should be made with Mr. F. J. Tone, Carborundum Co., Niagara Falls, N. Y.

The meeting will be held at the Clifton Hotel, overlooking the Horseshoe Falls, on Canadian soil.

The Niagara Falls Committee also makes great efforts to render the social functions of the meeting as attractive and enjoyable as possible. There will be a smoker on Thursday night, after Mr. Acheson's presidential address, and a banquet on Friday night.

The afternoons of Friday and Saturday will be devoted to excursions and visits. One of the newer large electrochemical works, which started operation after the last meeting of the society in Niagara in 1903—the plant of the Funding & Development Company (producing caustic soda and chlorine by the Townsend process)—will probably be open for inspection.

On Saturday night a gorge trolley ride will be made, to be followed by an informal entertainment.

The membership of the society has now increased above 1000. Dr. E. G. Acheson, of Niagara Falls, is the president, and Dr. J. W. Richards, Lehigh University, South Bethlehem, Pa., is the secretary of the society.

An Extravaganza Night at the Chemists' Club.

The monthly smokers of the Chemists' Club of New York City have always had the distinction of being exceedingly enjoyable and democratic affairs, productive of good fellowship and promoting a better understanding between all classes of chemists represented in the membership of the club.

At the smoker of Feb. 27 the club ventured for the first time upon the field of extravaganza and did so with immense success. A "sole session" of the "Komists Club of Manahatta" had been called, and the following list of papers had been announced:

Theodore Roosevelt: "Non-stoechiometrical Combination of Undesirable Elements."

Marsten T. Bogert: "Natural Resources of Conversation."

William H. Taft: "New Researches in the Fatty Series."

Thomas J. Parker: "On the Use of Ni in Medal Production."

William J. Bryan: "On the Sodium Chloride and Magnesium Sulphate Content of a Certain River."

Albert P. Hallock: "On Methods of Extracting Rebates from Gas-Charged Artificial Waters."

Maximilian Toch: "A Paint that Won't Come Off."

Jokichi D. Takamine: "The Japanning of China."

Those who actually presented "papers" were the president of the club, Dr. Morris Loeb, Dr. Hugo Schweitzer, Dr. Leo Baekeland, Dr. M. T. Bogert, Mr. T. J. Parker, Dr. R. W. Moore, Dr. Maximilian Toch and Dr. J. D. Takamine.

The attendance was very large and exceedingly appreciative. Refreshments "warranted poor food by Dr. Wiley" were served to the survivors.

Electric Pig Iron Plant in Norway.

The Aktiebolaget Elektrometall, of Ludvika, Sweden, will erect in Norway what will be the first electric smelting plant in the world for the production of pig iron on a commercial scale.

The first installation will be built this summer, and includes two iron-ore reduction furnaces of 2500 hp each and two steel furnaces of 600 hp each. All furnaces will be operated with two-phase current. The plant will later be enlarged by erecting four more iron-ore reduction furnaces of 2500 hp each and four steel furnaces of larger size than 600 hp.

At present the drawings and specifications for this plant are worked out. Besides the electric smelting and refining plant the installation will include a rolling mill. The plant will be erected in a perfectly modern and commercial way, as everything is newly designed.

For this information we are obliged to Dr. Eugene Haanel, who recently investigated for the Canadian Government the electric reduction furnace developed by the Aktiebolaget Elektrometall at Ludvika.

New York City Proposed for the 1912 International Congress of Applied Chemistry.

In our March issue, page 104, we reported on a preliminary meeting at which the project was discussed to issue an invitation to the London International Congress of Applied Chemistry (to be held this spring) to hold the next congress, in the spring of 1912, in New York City.

A general meeting of representatives of American educational institutions, scientific organizations, manufacturing corporations, etc., has been called for April 3. The meeting will be held at the Chemists' Club, New York City. Dr. Hugo Schweitzer is the secretary of the temporary committee.

New York Section American Electrochemical Society.

A well-attended meeting of the New York section of the American Electrochemical Society was held on March 1 at the Chemists' Club, New York City. Dr. Chas. Baskerville was chairman and Mr. A. von Isakovics, secretary.

Two very interesting papers were presented, the first, by Dr. Frank K. Cameron, of the U. S. Department of Agriculture, on "Electrochemical Methods in Soil Investigations"; the second, by Dr. L. H. Baekeland, on "The Uses of Bakelite (see our March issue, page 111) for Electrical and Electrochemical Purposes." Since both papers will also be presented at the general meeting of the American Electrochemical Society, at Niagara Falls, in May, we defer our report until that time.

Nitric Acid from Air.

General Director S. Eyde, well known as one of the inventors of the Birkeland-Eyde process for the fixation of atmospheric nitrogen, presented on Feb. 13, 1909, a paper in Christiania before the Norwegian Society of Engineers and Architects. The paper is printed in the Norwegian paper *Aftenposten* No. 87, Feb. 13, 1909; a German translation may be found in the *Zeitschrift f. Electrochemie*, March 1, from which the following notes are prepared:

About $6,000,000 have been invested so far in the Norwegian nitric acid industry in the plants at Notodden and Svalgfos and at the rivers Rjukan and Vamma. By the end of 1910 these plants will be complete and the investment will then be about $15,000,000.

The Notodden plant has met with unexpected difficulties. Three months after starting the generators broke down. Nevertheless, the year 1908, which was the first year of operation, yielded a total income of $536,000. After deducting the expenses of the operation, general expenses and amortization there remained a net gain of $134,000.

The companies interested in the Birkeland-Eyde process have reached an understanding with the Badische Anilin und Soda Fabrik which has developed another process. The results which will be obtained at an experimental plant now in course of erection at Notodden will decide whether the furnace of the Badische Company or the furnace of Birkeland and Eyde shall be used for the final large plant for which money has been procured by the co-operation of the two companies.

The Iron and Steel Market.

The month elapsed since our last report was written has fully justified the early opinion that the declaration of an "open market" in steel products really meant nothing but the dropping of prices, in various lines, to new levels, which would be held with as much uniformity as had been the case with the previous prices. There have been no additional reductions in the lines which had developed new prices at the time our last report was written. Plates and shapes remain at 1.30 cents a pound and bars at 1.20 cents a pound, while steel pipe continues at the nominal discount of 80 off list.

No reduction has been made in wire products, and the prospective reduction may be delayed for several weeks, as it is desired to allow jobbers to reduce their stocks. Wire products are on the basis established by the $2 a ton reduction of June 9, 1908, following the $1 a ton advance of Sept. 3, 1907.

Sheets have dropped from $3 to $6 a ton from former official prices, while tin plates have been reduced 25 cents a box.

As was noted from time to time, the old prices were shaded more or less. Compared with the old nominal prices the reductions have been as follows, per ton of 2000 lb.: plates and shapes, $6; steel bars, $4; steel pipe, $10 on sizes ¾ in. to 6 in., but $8 on some other sizes; sheets, an average of about $4 on black and $5 on galvanized; tin plates, $5. These lines comprise about two-thirds of the total finished steel tonnage, the lines not thus far reduced, wire products and standard rails, comprising about one-third. Giving each reduction a weight equal to the tonnage output of the product, the average reduction in the lines reduced may be stated at about $5.50 per net ton. Inasmuch, however, as there has been more or less shading for months in several of these lines, the reduction from the actual market can hardly be estimated at more than $4 a ton.

The new sheet market did not develop as rapidly as did the market on plates, shapes, bars and pipe. The old schedule of differentials between gages had become somewhat unsatisfactory in both black and galvanized sheets, and the market had to develop some new differentials. A meeting of independent manufacturers was held, in view of the fact that the leading interest no longer had an "official" price, and adopted, as the nominal official prices of the independents, a schedule involving the changes in differentials which the leading interest had just adopted. The basis thus adopted was 2.30 cents per pound for black and 3.30 cents for galvanized, No. 28 gage, the former official prices (subject to a 5-cent rebate) being 2.50 and 3.55 cents. In black the differential between 28 and 29, and between 28 and 27 gage, was reduced from 10 cents per 100 lb. to 5 cents, while in galvanized the differential between 28 and 29 gage, and between 16 and 17 gage, was reduced from 15 to 10 cents. Thus, the reductions from the former net official prices, in this schedule, are $3 a net ton on black and $4 a net ton on galvanized, for 28 gage, while the reductions on 29 gage and lighter are a dollar more, and on black 27 and heavier and on galvanized 16 gage and heavier, a dollar less. The new official prices are only supposed to obtain on carloads; on attractive orders they are shaded $1 to $2 a ton according to circumstances.

The iron pipe manufacturers have reduced their regular list by two points, about $4 a net ton, in contrast with the five-point reduction in steel pipe. The Eastern manufacturers made a somewhat larger reduction. On account of the cost of raw materials and the high labor cost in making iron pipe it was impossible to make as large a reduction as was made in steel pipe.

The tin plate reduction was announced by the American Sheet & Tin Plate Co. on March 10 and promptly met by the independents. There has been a period of uncertainty during which the manufacturers insisted there would be no reduction. There had been no shading whatever in tin plate, and the reduction was made solely in order to bring out more tonnage. This, indeed, was the principal reason for all the reductions. There had been shading in a number of the products, but that shading was not the chief cause of the general reduction.

The crude steel market gradually settled down to a reduction of $2 a ton in both billets and sheet bars, making billets $23, f.o.b. Pittsburgh, and sheet bars $25.50, delivered Pittsburgh. The system of adding half the freight from Pittsburgh was abandoned, and this has thrown the market open, at distant points, so that the few sales made have not, as a rule, been at the full freight advance above Pittsburgh. It has even been reported that the $25.50 delivered price on sheet bars in the "zone" has been cut by about 50 cents.

Partly by reason of rather aggressive shading by some Western interests, and partly as a recognition of the growing importance of the Chicago district as a producing center, the freight differential above Pittsburgh has been partly abandoned and prices have been somewhat irregular in the West. Most business in plates, shapes and bars has probably been done at a 15-cent advance at Chicago, the freight being 18 cents from Pittsburgh.

Business was practically suspended in steel products immediately after the decision of Feb. 18 to let the market seek

new prices. Early in March a moderate amount of buying appeared, and this has since increased, but it has hardly brought the bookings up to the average of the first six weeks of the year. The bookings, however, are accompanied by specifications, the manufacturers refusing to take extended contracts.

There has been a disposition on the part of buyers to await lower prices than those lately developed and to buy only for immediate necessities. The business of the country generally is awaiting the settlement of the tariff. The steel industry is not especially perturbed. It recognizes that the rates of the Payne bill are the minimum and that any changes made will in all probability be in the nature of increases. The trade is more concerned in having the matter out of the way than of having the rates advanced. With the exception of merchant steel bars there would be little danger of imports, with the Payne rates, now that domestic prices have been so reduced. The tariff matter is acting as a drag on business generally rather than on the steel trade in particular.

There has been a fair amount of activity in New England at the expense of prices, the Southern furnaces making sales on the basis of about $11.50, Birmingham, against $13 at the beginning of the year, while Buffalo and nearby furnaces met the delivered prices by making sales at the equivalent of about $14 at furnace. In the Central West there have not been enough sales to establish a definite market, but prices have been obviously weak, and from 25 to 50 cents less can be done on most grades than a month ago. Approximate quotations, f.o.b. valley furnace, may be named as follows: Bessemer, $15.50; basic, $14.75; No. 2 foundry and malleable, $14.50; forge, $13.75. Prices delivered Pittsburgh are 90 cents higher.

CORRESPONDENCE

The Electrolytic Reduction of Aluminium as a Laboratory Experiment.

To the Editor of Electrochemical and Metallurgical Industry:

Sir:—I have read with great interest the article in your January issue (this journal, Vol. VII, p. 19, 1909) from the pen of my friend Dr. M. deK. Thompson.

Firstly I may say that Mr. Thompson has performed an undoubted service by unmasking some of the difficulties which lurk in the way of the reduction of aluminium on a laboratory scale, difficulties which have militated against a detailed study of the Hall and Héroult processes which is so urgently needed.

That it would be possible for one investigator to "easily reproduce" the results of a colleague, scarcely seems probable in the case of a process so dependent for success on the exact balancing of various factors as in that under consideration. Even Haber and Geipert point out (*Zeit. f. Elektrochemie*, Vol. VIII, 1902) the influence of the relative dimensions of their apparatus and there can be no doubt that by substituting highly heat-conductive graphite for amorphous carbon, Mr. Thompson largely altered this influence.

Coming now to the most interesting portion of Mr. Thompson's paper, namely, his reference to what he terms the "anode effect," I do not think that Mr. Thompson's observation of this phenomenon is unprecedented. Thus, for instance, Winteler states on page 73 of his pamphlet "Die Aluminium Industrie" (Braunschweig, 1903) that the normal voltage on an aluminium furnace is 7 to 8 volts, but that as the alumina in the bath is consumed, the voltage rises and is only brought down again by the stirring in of fresh alumina. There can be little doubt that this was the cause of the phenomenon observed by Mr. Thompson. This would explain the fact that every time fresh cryolite (containing alumina) was added, the electrolysis started up again. The appearance of the anode as described by Mr. Thompson is in further confirmation of this view:

"It seems that where it dips into the melted cryolite a film of gas covers it, insulating it from the cryolite."

In their article on the electrolysis of pure cryolite (*Ann. d. Chem.*, 320, p. 237, 1901) Muthmann, Hofer and Weiss state that the anode is not "wetted" at all by the molten cryolite and that the current enters the electrolyte by means of innumerable tiny arcs. It would be interesting to learn whether Mr. Thompson observed this arcing.

Coming now to the individual experiments:

It is scarcely conceivable that a perfect solution containing 20 per cent of alumina was obtained at a temperature so low as 910 C., although a recent article by Moldenhauer (*Metallurgie*, 6, 14, 1909) lends color to Mr. Thompson's view. It is most unfortunate that further temperature measurements are not given, as these would have been of the greatest interest to those concerned in the manufacture of aluminium. It would also have been of interest if the quantity of cryolite used for each experiment had been stated.

That the "anode effect" should have appeared in experiment II immediately after the addition of 30 grs. of Al_2O_3 is at first sight not consonant with the opinion expressed above as to the cause of the phenomenon. However, in view of the effect of temperature and circulation on the rate of solution of alumina in cryolite this fact is perhaps not surprising. The influence of this latter condition is well seen in experiment III, where some parts of the bath showed the anode effect while others were working normally.

May not the "thickening" of the bath, described in experiment III, have been due to the sudden cooling of the flux which must have resulted from the reduction of the current? This would cause precipitation of alumina from a solution supersaturated at the lower temperature.

In conclusion I would draw attention to the fact that in experiment III the phenomenon was observed less frequently during the latter part of the run than at the commencement. This appears to point to the conclusion that during the earlier stages of the experiment, although electrolysis was proceeding the electroylte was becoming richer in alumina until a state of equilibrium had been reached. I hope to be in a position to treat this question quantitatively on some future occasion.

London, England. Richard Seligman.

Steel from Ore in the Electric Furnace.

To the Editor of Electrochemical and Metallurgical Industry:

Sir:—For some reason Mr. Stassano seems to be under the impression that in the remarks I have made on the Lash process, the intention is to criticise his work adversely. Nothing could be farther from my intention, as I have the highest admiration for the excellent work Mr. Stassano has done in the electrometallurgy of steel.

On the other hand, Mr. Stassano did criticise the Lash process adversely, and I merely attempted to show in what way it might be advantageous. I do not think that as yet it has been shown that the advantages are non-existent. Probably, however, the Lash process has not been explained with sufficient clearness and, therefore, so far as it is concerned it is proposed to present a paper on the subject at the forthcoming meeting of the American Electrochemical Society.

As regards my assertions as to the cost of power, about which Mr. Stassano has "strong doubts," I think that most users of electric energy will agree with me that obtaining it at $8 a horse-power-year is not easy in this country. Most certainly it cannot be obtained at that rate, nor even at 50 per cent more than that rate, at Niagara Falls. There are other places where power can be obtained more cheaply than here, but then there are other considerations, such as freight charges, etc., which counterbalance this advantage.

Niagara Falls, N. Y. Francis A. J. FitzGerald.

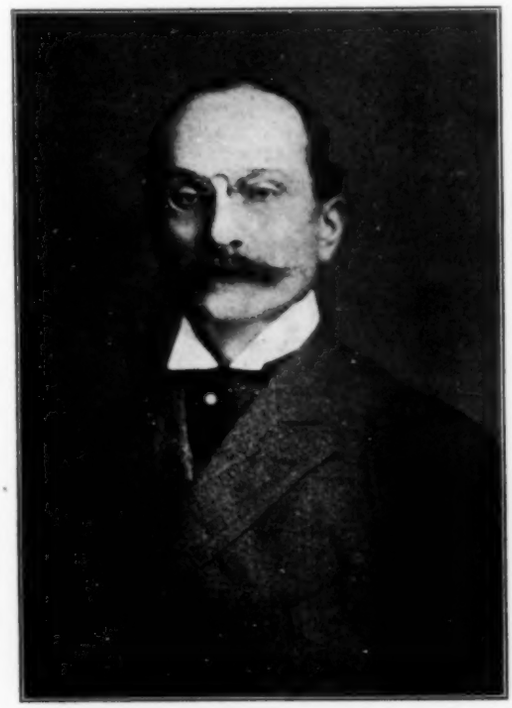
Schweitzer Celebration.

A commers was given on March 13, 1909, to Dr. Hugo Schweitzer, celebrating the fifteenth anniversary of his services as secretary of the New York section of the Society of Chemical Industry, the twentieth anniversary of his landing in America, the twenty-fifth anniversary of his doctorate, and the ninth anniversary of the organization of the Verein Deutscher Chemiker.

Some 300 chemists participated in the commers, which was held in the beautiful banquet hall of the Liederkranz Club of New York City.

Mr. Elwood Hendrick presided. Würzburger beer was served, and later in the evening a cold dinner.

As Dr. Schweitzer is known to every chemist in this country through his fifteen years' service as the American secretary of the Society of Chemical Industry, and through his long connection with the Farbenfabriken of Elberfeld Co., there is here no necessity of a long biography. But we quote the introductory notes by "R. C. S." from the commers program.



HUGO SCHWEITZER.

"Quod felix faustum fortunatum que sit—runs the benevolent greeting of the diploma which the German alma mater confers on her doctor-sons, exhorting them to hold aloft the banner of science, progress and humanity, to be warriors bold in behalf of her ideals and conquerors of new realms. Thus equipped, our hero lingered somewhat longer at various seats of learning, having already served his year with the horse-marines, to still further improve his mind and show frivolous youths how, and then sauntered forth into the world to wring the last saccharose crystal from phlegmatic treacle and to rival the shades of the rainbow. After a lustrum new yearnings rose to his breast, and tucking the aforementioned diploma and letter of credit, on credit, in his recticule, he shook the Fatherland's dust off his slippers, just as if he were the knockers one, held in low esteem by an exalted personage; and thus he came to our beloved country.

"One fine morning he walked down the gangplank with his hands in his pockets, to increase their receptivity, and Cæsar's famous dictum about the dice-box on his lips. In the sunny Southland he fondled once more saccharine juices and for a few months dabbled in plastics in the shadow of old Greylock. Then the metropolitan vortex drew him in, and near the lair of predatory wealth he dispensed chemistry, causing said wealth to change places. We just pause to note that at this time he began to taste connubial bliss, and in due season domestic symphonies reverberated through the house.

"Presently his trustful nature brought him into alliance with a bicontinental trust, in whose service he has slaved ever since, doing the grand circuit, growing in jollity, dignity and merit, old Pactolus leaving a copious sediment as of yore. With congresses and conferences, banquets and bureaux, his life has been like the busy bee's. Say, dear colleagues, are there any more like him? And now on with the commers! As Lauriger puts it: Nunc est bibendum, nunc pede libero pulsanda tellus."

There were salamanders and songs—Gaudeamus; a biographical song, "Hugo on an Autumn Day"; "My Country, 'Tis of Thee," "Deutschland, Deutschland über Alles" and many others.

Prof. Chas. F. Chandler was the toastmaster, and was as jovial and eloquent as ever. He traced the career of Dr. Schweitzer since his graduation from the University of Freiburg, and referred particularly to a number of valuable discoveries by Dr. Schweitzer, such as that of azophenylene, the base of a series of important dyestuffs, as well as to his numerous papers on technical subjects in chemical journals. But apart from his scientific contributions Professor Chandler said that the American chemical profession owed much to Dr. Schweitzer for the conspicuous part he has taken in promoting a closer union among chemists and for his constant efforts in advancing the interests of the younger members of the profession. Professor Chandler concluded by saying that he had not only admired Dr. Schweitzer, but had learned to love him.

If possible, the personal note was even more emphasized in the felicitous speech by Mr. Thomas J. Parker, who presented to Dr. Schweitzer a silver tea service as a lasting souvenir of the occasion, with the injunction to "use it."

Dr. Schweitzer expressed his thanks in an impressive speech of great modesty, leading to a climax of beautiful sentiment. He said little could be accomplished by an individual. "For chemists it is indispensable to work together. It has been said success can only be obtained, if above all, science and technique support each other. If this be true—and I firmly believe in it—then the future of chemistry in our great country is brilliant indeed. For we have succeeded in creating a democracy of chemists, with the Chemists' Club as its center, where we associate so closely that the proper exchange of ideas becomes inevitable.

"Here the young graduate comes in contact with the teacher of our science who has made an international reputation for himself, and here the young beginner with the proud distinction of earning fifteen dollars per week meets on an equal social footing the millionaire captain of industry. All are ready to help and to assist by word and deeds, and all are ready to get as much pleasure and enjoyment out of such association as possible. There is no envy, no jealousy; on the contrary, there is general rejoicing at whatever any of us may accomplish. There does not exist such a union of kindred spirits in any other place in the world, and, like myself, you all consider an evening spent among our friends in the Chemists' Club the most delightful of all social functions.

"I wish and hope that it may ever be so, that we may ever be helpful to one another, and if need be to our families, eager to work, just as eager to play, friends of all good fellows, enemies of the dishonest fakirs and ignorant fanatics."

A few more impressive speeches were made. Mr. Seitz, as president of the Liederkranz Club, expressed his pleasure at having this celebration held in their club. It has always been the mission and the privilege of the Liederkranz, not only to advance musical art, but anything that tends to promote German-American co-operation in the active furtherance of culture and science.

Mr. I. J. R. Muurling, president of the Farbenfabriken of Elberfeld Co., while expressing his high appreciation of Dr. Schweitzer as a man and a scientist, was inclined to think that

he owed much of his incentive to his work to his better-half, whose health he proposed.

Comptroller Metz made some remarks in breezy fashion. The United States has always had practical men who knew how to do things. Germany has been the leader in producing men who also knew why. He expressed the hope that there would be an advance in chemical education along the combined lines of how and why in this country.

Then there were more songs, including the irrepressible Clementine. There was an excellent, amusing, attractive, and suggestive vaudeville performance. To sum up, it may truly be said that it was one of the most enjoyable social gatherings of chemists ever held in this country—worthy of the "Democracy of American Chemists" and of the man who has done so much in building it up.

Corrosion of Zinc-Plated Iron Wire and Corrosion of Tubes and Shells of Steam Boilers.

In our Vol. VI, page 492, we gave a short abstract of a paper presented by Dr. W. H. Walker, of the Massachusetts Institute of Technology, before the American Electrochemical Society at its New York meeting last autumn. As the paper has now been printed in full in Vol. XIV of the *Transactions*, we supplement our former abstract by giving in full those portions of the paper which relate to two very interesting, practical problems; one is the protection which a zinc coating gives to an iron surface, with special reference to the corrosion of barbed wire fencing.

Although the protection which a zinc coating gives to an iron surface is universally mentioned in text-books, the fact that, in consequence of the protecting action to the iron the zinc itself will rapidly be dissolved is not mentioned. Both actions will be the more complete the more energetic is the solution of the zinc and the correspondingly greater flow of current from the zinc to the iron (the zinc and the iron forming a short-circuited galvanic couple).

But the flow of current will depend, among other things, upon the resistance offered to its passage through the water. Hence it should be possible to get water so pure, or to place the iron so far from the zinc that the electromotive force of the system could not overcome the resistance, and no appreciable current would flow, and the iron should corrode as though no zinc were attached to it.

It was found that Boston water as drawn from a tap in the laboratory had a sufficiently low conductivity, so that zinc attached to a piece of sheet steel would protect it when placed in this water for only a distance of three-fourths of an inch. When a little common salt was added to the water the protection was extended for a foot and one-half or more. Hence, in order than zinc may protect iron from corrosion, it is necessary to have present in the water surrounding the two enough electrolyte to insure a low resistance to the flow of the current generated by the solution of the zinc.

The fact that the presence of a metallic iron surface accelerates the corrosion of zinc has an important bearing upon the protection of such structures as **barbed wire fencing**, or whenever both an iron and zinc surface are exposed. In making barbed wire fencing the wire is first galvanized and then wound into fencing, the cross-wires forming the barbs being cut at an angle, in order to make a pointed barb. This freshly cut surface of iron is thus exposed and so furnishes just the surface required for depolarizing the zinc surface and thus greatly increasing the rapidity with which the zinc coating will corrode. As the zinc coating thus recedes from the iron surface, the latter rusts, on account of the low conductivity of the water film on the two, and this is the explanation of why deterioration of a barbed wire fence always starts at the barbs and travels from there along the strands.

It would seem worth while in this connection to pass the finished barbed wire through a wet galvanizing bath in which the wire should be cathode and be surrounded by a zinc anode, so that the current would be attracted to the barbs, and hence the zinc deposited almost exclusively on just the points where it is needed. Little if any would be plated on the wire strands.

In examining barbed wire fencing which has been exposed for two or three years, it is not infrequently found that one of the two main unit wires making up a strand will have corroded much faster than the other which is close alongside of it and in direct contact with it. Three factors may enter into this difference. First, the steel may itself be inferior in one wire; second, the zinc coating may be thinner, i.e., "wiped" closer on one than on the other; and, third, the zinc coating may be contaminated with a zinc-iron alloy. While the first two are matters understood by the wire makers, the third is not so easily detected.

The alloy known as "hard dross" by the galvanizers, and which, owing to its high melting point, settles to the bottom of the galvanizing pot, contains from 4 to 6 per cent. of iron. This is in reality a mixture of the alloy Zn, Fe and zinc, and, while the properties of zinc still predominate, the effect of the presence of the alloy may be easily detected.

Contrary to what might be expected, the iron zinc alloy Zn, Fe is electronegative to iron; that is, it will act like platinum or mill scale and accelerate the depolarization of the cathode (hydrogen) surface, and thus aid corrosion.

The second practical problem discussed by Dr. Walker at some length is the **corrosion of tubes and shells of steam boilers.** The function of the oxygen (with which the normal feed water of a boiler is saturated) is here the same as in other types of corrosion, and, as boiler tubes cannot be protected by paints or other coatings, the detrimental effect of the oxygen must be counteracted in some other ways.

If the feed used be perfectly free from dissolved salts there is lacking in the boiler that protective coating of scale which, while it reduces the heating efficiency of the boiler, also protects the iron of the boiler from the access of oxygen. In such a case it is well to feed into the boiler, when first put into commission, enough water containing scale-forming salts to thoroughly coat the shell and tubes with a layer of hard boiler scale. This practice is very common in marine boilers which are to be fed with distilled water.

Although the presence of alkalies inhibits the corrosion of iron by reducing the hydrogen concentration, and although, as Dr. A. S. Cushman has shown, the presence of bichromates in solution greatly inhibits this action, the best practice is to remove oxygen from the feed water before it is introduced into the boiler, just as it is best practice to remove the scale forming salts of the ordinary feed water before this is used.

As the solubility of oxygen in water rapidly decreases with rise in temperature, by far the larger portion of the oxygen dissolved in natural waters, or in distilled water, is removed by heating the water to near its boiling point. If, in addition to the application of heat, a vacuum be maintained over the water the dissolved oxygen is practically all removed, and such feed water will never corrode the boiler. Such an arrangement has been in use in a few of our largest steam generating plants with the greatest success.

Even if no diminished pressure can be maintained over the hot feed water, the mere heating to the boiling point will drive out most of the dissolved oxygen. If, therefore, an open feed-water heater be employed, the feed water is deprived of its oxygen without additional expense for the heat, because the feed water in any case must be brought to its boiling point the moment it gets within the boiler. This method of treating boiler feed water has also been found very efficient in the power stations of some of our large electric railway companies.

A third method of depriving the feed water of its oxygen is to carry the same through a tank filled with small pieces of scrap iron. The accumulated iron hydroxide must, of course,

be cleaned out of the tank periodically and the scrap iron renewed. But from the point of economy it is, of course, much cheaper to pit and corrode scrap iron in a tank than it is to corrode the tubes inside the boiler, so that this method, especially if combined with an open feed-water pre-heater, is in the end a very economical and highly efficient one.

If, for any reason, it is not possible to remove the oxygen from the water, before it is fed into the boiler, numberless boiler compounds are proposed to counteract the effect of the oxygen within the boiler. Such a method is, of course, irrational and is nothing more than voluntarily taking poison, with the expectation and intention of taking at the same time an antidote therefor. The compounds and mixtures which have been proposed for introduction into a boiler include practically every thinkable material extant.

The basis of most of them, however, is sodium carbonate in the form of soda ash, and are effective only insofar as they reduce the hydrogen concentration in the water. A considerable portion of the soda added is frequently consumed in precipitating the scale forming salts of the water, and is as a rule of low efficiency as an anti-corroding ingredient. Inasmuch as an alkaline solution of the ordinary tannins or tannin extracts breaks up more or less when subjected to the heat and pressure of a steam boiler into gallic and pyrogallic acids, which are energetic absorbents of oxygen, a solution of this material is efficient as a boiler compound for preventing corrosion.

A very old method is, of course, the introduction of pieces of metallic zinc into the boiler, which operate in accordance with well-known principles. It is necessary, however, to maintain good electrical contact with the iron and to have in the water sufficient electrolyte of some sort to carry the current from the zinc to the iron. For the protection of condenser jackets using sea water this method has been found to be perfectly satisfactory and entirely trustworthy.

Autogenous Welding of Aluminium.

By M. U. Schoop.

Autogenous welding of metals has been developed into a thoroughly practical method for metal workers, especially since the gases required for the welding flame (hydrogen, oxygen, acetylene) have been placed on the market in compressed form and at a reasonably low price. For, as a matter of fact, there are very few metal-workers' shops now in existence which manufacture the required gases themselves.

The prototype of the modern autogenous welding process is the lead-burning process in which the joints are made without the aid of a special solder containing a foreign metal. As to terminology, one should speak of autogenous welding, not soldering, since the characteristic feature of soldering is the use of a solder of a foreign metal with low melting point.

While a number of metals, like lead, steel, also copper, can be welded autogenously without any difficulty, if only the flame temperature is sufficiently high, considerable difficulties are experienced with other metals, like nickel, silver and aluminium. In the case of copper, if thick copper sheets are to be welded, quite considerable experience is necessary in order to avoid brittle joints.

The existing patent literature shows that a great many inventors have been interested in the problem of soldering or welding aluminium. By far most of these experiments or suggestions have not been introduced into practice,[1] as they intended to accomplish something that is apparently impossible, namely, to make *durable* joints with the aid of foreign metals. In my collection of patents, which is by no means complete, I have some 50 patents for soldering aluminium and aluminium alloys.

The question why it is so difficult to weld aluminium autogenously, in spite of the relatively low melting point (about 660° C.), can best be answered by a little experiment. If four or five thin aluminium wires are twisted together and the free end of the bundle is held into a strong Bunsen flame, the wire ends do not weld together, but remain separate, being covered with a white and hardly perceptible oxide film.

Aluminium surfaces tend to become covered with a thin oxide film, even at ordinary temperatures, and, this is the reason why, if one tries to weld two surfaces, the fluid metal portions will not unite.

The problem of aluminium welding is, therefore, to remove this very thin and tough oxide film by some chemical or mechanical means. For example, the oxide film can be ruptured by means of a suitable instrument, so that the pure fluid metal portions can then unite. But this rather rudimentary method

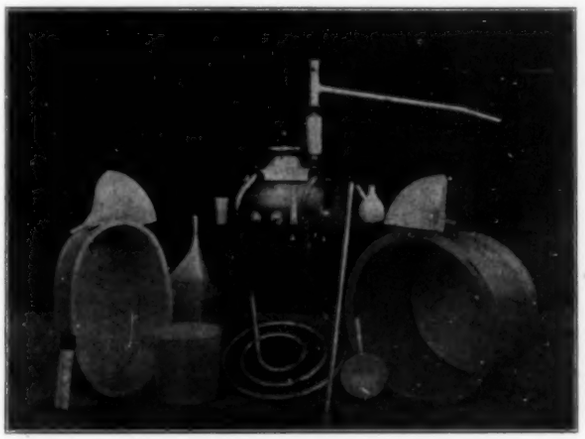


FIG. 1.—AUTOGENOUS WELDING OF ALUMINIUM.

can be used only in a few cases of practice, namely, when strong solid metallic pieces are to be welded. With thin sheets or wires this method would surely be unsuccessful, even if the operator were highly skilled.

The elimination of the oxide film by chemical means is, therefore, the only method to be considered. In other words, the object is to provide a pure metallic aluminium surface during the felding process. If the surfaces to be joined are cleaned so as to be pure aluminium, they will satisfactorily weld together.

The question is, therefore, which substances are suitable as fluxes for dissolving the aluminium oxide and which other properties are required of such a flux. In the first place, we might consider the use of some agent, which simply excludes the air, like glass-powder or borax, or the use of a very hot flame which might reduce the oxide without any reducing agent. But experiments along these lines will soon show that success cannot be obtained in this way and that the use of a reagent which dissolves the oxide cannot be avoided.

Other requirements besides the solvent action on the oxide are the following: The melting point should be near that of aluminium. The evaporating point should be as high as possible, i. e., the flux must be stable under the influence of the flame. When fluid, the substance must spread over the hot aluminium surface as a thin enamel-like layer, cutting off any access of air to the surface. Finally, the substance must be free from oxygen and must not have any tendency of combining with aluminium.

Only a flux which fulfills all the above requirements, renders autogenous welding of aluminium possible in such a way that the welded metal differs neither chemically nor physically from normal unwelded metal. For my first experiments, which I made as early as 1900,[2] I used potassium bisulphate, $KHSO_4$, which is stated in chemical handbooks to be well suited for dissolving materials which are soluble only with difficulty, like

[1] An exception is the welding process of Heraeus in Hanau (German patent 118,868 of 1900 and Zusatzpatent). This process has been in use on a commercial scale for a number of years.

[2] Chemiker Zeitung, 1907, No. 60; M. U. Schoop on the autogenous welding of aluminium.

aluminium oxide. As the melting point (300°) is too low, I raised it by addition of some potassium sulphate, K_2SO_4, (melting point, 1080°).

However, this mixture did not prove sufficiently effective in practice for dissolving the oxide so that the results were first not quite satisfactory. The potassium bisulphate gives off water, and sulphur trioxide under the action of the flame and changes thereby into potassium pyrosulphate. These potassium salts have the good property that they do not decompose at high temperatures; when molten they form an easily fluid, protective layer on the aluminium surface.

I then tried a great many substances with a pronounced etching effect on aluminium, like potassium hydroxide, hydrofluoric acid, chlorates, etc. But a really satisfactory solution of the problem was obtained only by the use of alkali chlorides. In working out the process, I had the great advantage that I knew thoroughly all the tricks of lead welding and was also intimately acquainted with the oxy-hydrogen flame.

As to the reactions which really occur in welding aluminium with an oxy-hydrogen flame and a flux, it seems that the matter is not as simple as might be thought from the above considerations. It rather seems that there is not only a chemical deoxidation of the metallic surface, but also a physical process similar to the solution of sugar in water. It is certain that halogen compounds are formed which evaporate and that the oxide film is removed in this way.

It is simpler to *solder* aluminium, as this is always successful if only the metallic surface is kept clean during the soldering process. If this condition is fulfilled, aluminium is really one of those metals which can be easily soldered with ordinary soft solder. But it is also well known that the original strength and quality of the joint thus obtained are lost slowly, but surely, especially in presence of water or moisture.

Although aluminium forms a series of alloys of technical importance, it is a rather sensitive and disagreeable metal, if in contact with another metal and with water.

In the galvanic series it is the first metal on the positive side, and has a remarkable tendency to electrolytic local action in the presence of foreign metals, with water decomposition and formation of hydroxide.

Moissan once recommended to the French army department an aluminium alloy with 3 per cent copper for bottles for the soldiers going to Madagascar. The reason of his recommendation was that the material becomes thereby much harder and tougher mechanically. This unfortunate experiment cost hundreds of thousands of francs; for after three or four months the bottles disintegrated completely and this experience has discredited aluminium (in spite of its unsurpassed hygienic and physiological qualities) to such an extent in France that up to the present day it has been found very difficult to bring aluminium into popular favor in France as a cooking and kitchen utensil.

To test the quality of a metallic weld, several methods may be used. Comparative tensile tests may be made of the pure metal and the weld. Or an investigation may be made whether the joint becomes the seat of e.m.fs. under certain experimental conditions, or whether thermo-electric currents are set up on heating. Further, a section may be made through the joint, polished carefully and etched, and then studied with the microscope. The latter method is especially suitable in the present case, as it is very sensitive and yields quick results which can be preserved photographically.

About three years ago the Conservatoire National des Arts et Metiers, in Paris, made for me a microphotographic investigation of welded aluminium sheets. It was found that the metal in the joint differed from the normal metal elsewhere only in so far as the structure in the joint was coarser and more crystalline.

There is nothing surprising about this, as the sheets are *rolled* aluminium, while the joints and their surroundings are *cast* aluminium To make an absolutely unobjectionable test, the sheets to be welded should be tempered first by heating to 350° or 400° C. and then the whole welded piece would have to be rolled. If two welded and non-tempered sheets are etched, for instance, with dilute hydrofluoric acid, the following observation is made: The attack of the acid is more manifest at the joint than elsewhere, and if the etching process is continued long enough, dentrites (with a direction perpendicular to the joint) appear of especially characteristic form. On the other hand, unwelded portions have not any evident typical metallic structure, even if the etching operation is continued for a long time. Evidently the original crystalline structure has been annihilated by the rolling process so that it is no longer visible.

It is similar with most of the other metals which can be rolled, like lead, tin, copper.[3] But it is clear that it is easy to

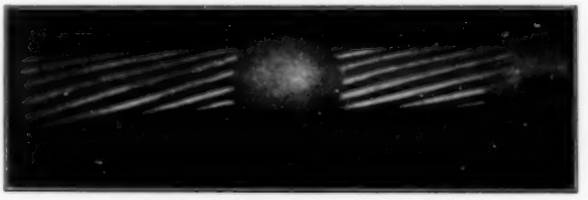


FIG. 2.—WELDED ALUMINIUM CABLE.

impart to the joint the normal strength and tenacity by mechanical treatment afterward, since aluminium can be hammered, rolled, etc., at will, just like copper. According to my experience, quenching in cold water has no appreciable effect on the joint, but for the quality and durability of the joint it is important that the aluminium be as pure as possible.

Welded aluminium wires were also tested as to electric conductivity. These experiments were made by Prof. J. Sahulka, of Vienna. He found that the reduction of conductivity was practically negligible. A wire of 3 m length and 4 mm diameters would increase about 0.006 per cent in resistance on account of one joint. According to Professor Sahulka "the results indicate that no foreign metal is present in the joint, or, in other words, that the pieces are welded together, not soldered together."

By means of mechanical tests, Professor Kirsch, in Vienna, found that aluminium strips welded together by my process have the same tensile strength as non-welded strips. Wires welded together by the same process have the same torsion strength as non-welded wires. "The results of the mechanical tests indicate that there is no foreign metal in the joint, or, in other words, that we have to do with a welding, not a soldering, of the aluminium pieces."

I would like to refer briefly to aluminium as a substitute for copper for electrical conductors. As it has been the leading country in the case of electric traction, the United States has become the pioneer in the use of aluminium for transmission lines. In the United States aluminium conductors have already been used on a large scale at a time when the price of aluminium was still three or four times the present price, and the results obtained with aluminium lines in the United States have been quite satisfactory.

It can be easily seen that not only the cost of the metal itself is much less, but that there is also a saving in weight and freight. For instance, let us consider two lines, both of 1000 m length and of the same conductance. The copper line has a section of 1 sq. cm and therefore weighs 89 kg. If aluminium has a conductivity of 65 per cent in comparison with copper (100 per cent), the equivalent aluminium line has a cross-section of 1.65 sq. cm, and weighs 42.85 kg.[4]

[3] See also the highly interesting paper by Wm. Campbell Das Gefüge der Metalle (Halle: Knapp).

[4] The comparative constants are:

	Aluminium.	Copper.
Specific weight, rolled	2.6	8.9
Melting point	660° C.	10,846
Hardness, hammered	4.5	3.5
Tensile strength, rolled	25 to 27 kg per sq. mm.	
Linear elongation	0.0423	

If for the sake of simplicity we now assume the price of copper and aluminium to be equal, namely, 2 francs (40 cents) per kilogram, then we have for the aluminium line a saving of 53 per cent in first cost of metal and a saving of 48 per cent in weight. In reality the conditions are even more favorable to aluminium, since any quantity of aluminium ingots can now be bought in Europe at 1.20 francs per kilogram (about 10 cents per pound).

Aluminium wires and cables are now joined by means of mechanical and more or less primitive couplings, and a certain loss of voltage at the joint is unavoidable. This has, naturally, a bad effect on long lines. It is different with welded lines, where there is practically no increase in resistance. Further, the welded joint cannot decompose, since there are no foreign metals present, and the joint can be made with the simplest means (gasoline soldering lamp and reduction paste) wherever required.

Fig. 1 shows a number of articles of aluminium welded by my method. Fig. 2 shows a welded aluminium cable. A second article will follow.

Garenne-Colombes, near Paris, France.

Reduction of Iron Ore in the Electric Furnace.

Mr. Remo Catani, engineer of the Société Elba, at Porto Ferraio, Elba, Italy, has recently made an interesting investigation of the possibilities of the electric furnace for iron-ore reduction in comparison with the blast furnace. From an abstract by Professor Neumann of Mr. Catani's paper in *Stahl und Eisen*, Feb. 24, we have prepared the following summary:

In the blast furnace it is theoretically possible to obtain the following temperatures:

1350° C. with moist cold blast.
1650° C. with dry cold blast.
1900° C. with moist blast of 700°.
2200° C. with dry hot blast.

In the electric furnace it is easy to produce much higher temperatures.

Compared with the daily output of a modern blast furnace, the capacity of an electric iron-reduction furnace is very low. But the matter appears in a different light if we consider the capacity for the same energy consumption. J. W. Richards in figuring out the reduction of magnetite ore with charcoal (assuming 30 per cent heat loss by radiation, also a complete loss of the latent heat of the gases which escape at 300° C., etc.; see our Vol. V, page 165) finds that the reduction of 1 metric of pig iron requires 112-kw-days, or 1 hp-day yields 6.5 kg of pig iron. If an electric furnace gives 8 kg of pig iron per hp-day, this must be considered quite a good result under present conditions. Héroult claims that with a 10,000-hp plant he can get 12 kg per hp-day, but this possibility must still be proven in actual practice in continuous operation. An electric-furnace plant of the same capacity as a 200-ton blast furnace would therefore require 25,000 hp.

The main difference between iron-ore reduction in the blast furnace and in the electric furnace is that the reducing agent is primarily carbon monoxide in the blast furnace and solid carbon in the electric furnace.

In the blast-furnace gases the ratio of carbon monoxide to carbon dioxide varies between 1.56 and 3.22, but in the average $= 2$. The higher this ratio the greater the fuel consumption.

If we assume the reaction to be $Fe_2O_3 + 9\,CO = 3\,CO_2 + 6\,CO + 2\,Fe$, then a production of 1000 kg of iron requires a consumption of 964 kg of carbon.

If we assume with Bell that iron oxide loses in the higher zones 25 per cent of its oxygen, we arrive at the following formula:

$$Fe_2O_3 + 3/4\,C + 6\,CO = 18/4\,CO + 9/4\,CO + 2\,Fe.$$

This gives a consumption of 723 kg of carbon.

The greater the extent of direct reduction by means of carbon the less the consumption of carbon. In cases in which ferric oxide is first reduced to ferrous oxide, the following equation is obtained:

$$Fe_2O_3 + 2\,C + CO = CO_2 + 2\,CO + 2\,Fe.$$

with a consumption of only 321 kg of carbon.

For the smelting process in the electric furnace the reduction may be assumed to be completely direct. In reality carbon monoxide will be formed, but will act as reducing agent in the cooler zones, as in the first of the above formulas, and the ratio of CO to CO_2 will be larger than otherwise, say, $= 3$. Taking the smaller lime addition in the electric furnace into consideration, Catani arrives at the formula

$$16\,Fe_2O_3 + 39\,C = 9\,CO_2 + 30\,CO + 32\,Fe.$$

This gives a theoretical consumption of 261 kg carbon per 1000 kg of iron.

In the experiments at Sault Ste. Marie under supervision of the Canadian Government up to 308 kg were consumed. The reduced pig iron contained 4.6 per cent C and 94.3 per cent Fe.

Catani calculates an example of iron ore reduction for the two cases of the blast furnace and the electric furnace. The consumption of ore is the same in both cases. The consumption of lime is less in the electric furnace, on account of the smaller amount of carbon in the carbon. The electrode consumption ($40 per ton) is figured as coke by Catani, but on account of the higher price he figures on 80 kg coke instead of 8.17 kg of electrodes.

The composition of the raw materials is as follows:

Ore: 70 per cent Fe_2O_3, 10 SiO_2, 0.2 Mn_3O_4, 0.7 P_2O_5, 0.2 SO_3, 3.0 Al_2O_3, 4.0 CaO, 2.0 MgO, 10.0 H_2O.

Coke: 85 per cent C, 10 ash, 2 volatile material, 10 moisture (?).

Lime: 95 per cent $CaCO_3$, 5 per cent impurities.

Blast: 1 per cent moisture (about 50 kg per 1000 kg iron).

Electrodes: 95.78 per cent C, 2.02 volatile substances, 2.20 ash.

The white pig iron to be produced shall contain 94 per cent Fe and 1 per cent Si. To produce 1000 kg of iron (containing 94 per cent Fe) 1920 kg ore are required. Since, together with the iron, other elements which are present are also reduced, the pig iron produced has this composition: 94 per cent Fe, 1 Si, 4 C, 0.57 P, 0.15 S, 0.23 Mn.

In the *blast furnace* the coke consumption is 1113 kg. There are required for reduction $964 \times 0.94 = 906$ kg, for the desired carbon content in the pig iron 40 kg, or together 946 kg carbon, equivalent to $946 \div 0.85 = 1113$ kg coke. The average coke consumption is, according to Junge, 1180 kg in American blast furnaces and 1127 kg in German furnaces.

To burn this coke a blast of 4947.4 kg of dry air is required, equivalent to 4997.4 kg of air with 1 per cent moisture. The lime addition is assumed to be 500 kg.

To produce 1000 kg of iron in the *electric furnace* 1920 kg of ore are required, and for this reduction 335 kg of coke. Since 70 per cent of the lime serve for slagging the impurities in the ore, 30 per cent for the coke impurities, there are required

$$0.7 \times 500 + 0.3 \times 500 \times 335 \div 1113 = 395 \text{ kg lime.}$$

Table I shows the quantity and composition of the gases in the blast furnace and in the electric furnace.

TABLE I.

	Weight per cbm. kg.	Blast furnace: Weight kg.	Blast furnace: Volume cbm.	Blast furnace: Composition in per cent Moist.	Blast furnace: Composition in per cent Dry.	Electric furnace: Weight kg.	Electric furnace: Volume cbm.	Electric furnace: Composition in per cent Moist.	Electric furnace: Composition in per cent Dry.
CO..	1.26	1408.6	1118.4	21.1	22.37	492	390.5	45.0	63.0
H_2..	0.09	17.9	210.0	4.0	4.24	3.5	38.9	4.5	6.3
CH_4.	0.72	10.0	13.9	0.3	0.32	3.0	4.1	0.5	0.7
N_2..	1.26	3805.7	3021.7	56.8	60.03	..	..	..	..
CO_2.	1.98	1317.5	665.3	12.5	13.04	363	183.3	21.0	29.9
H_2O.	0.81	225.4	278.4	5.3	..	202	249.4	28.7	..
Total....		6785.1	5307.7	100	100	1063.5	866.2	100	100

Weight of 1 cbm. moist gas, 1.278 kg. and 1.228 kg., respectively.

The calorific value for 1 cubic meter of gas is also calculated by Catani, and from his figures he calculates for both processes what surplus of power is obtainable from the "waste" gases, above the power required for the furnace plant itself. The surplus of power found by him is 1151 hp and 451 hp, respectively per 1000 kg of iron per hour.

The figure given for the blast furnace does not agree well with other known figures, and Neumann has therefore revised the calculation and finds 780 hp-hours for the blast furnace and 389 hp-hours for the electric furnace per 1000 kg of iron. The figure for the blast furnace agrees with older figures from practice: Greiner, 800 hp-hours; Uehling, 858; Thomsen, 868 (see this journal, Vol. III, p. 193).

The blast furnace requires $1113 - 335 = 778$ kg more coke than the electric furnace, or if, as stated above, the electrode consumption is figured as 78 kg coke, the blast furnace requires 700 kg more coke than the electric furnace for the production of 1000 kg of pig iron.

The comparison leads therefore to the following chief results:

In favor of the electric furnace: It requires 700 kg less coke than the blast furnace for the production of 1000 kg of pig iron.

Against the electric furnace: It requires electrical energy for heating the charge (which is not required at all in the blast furnace); moreover, the surplus power available from the waste gases is less with the electric furnace than with the blast furnace. The difference in the surplus power from the blast furnace and the electric furnace gases per 1000 kg of pig iron is 700 hp if we take Catani's figure and 400 hp if we assume Neumann's revised figure.

It is peculiar that, having revised this figure, Neumann continues to use Catani's figure in the further calculations. In the following we will give the calculations for both figures.

The above considerations permit us to state at once under which conditions the electric furnace can compete with the blast furnace. For this purpose we figure the above comparative advantages of the electric and the blast furnace in dollars and cents per 1000 kg of iron produced.

The 700 kg of coke, which are less required with the electric furnace than with the blast furnace, cost $0.7\,y$, if y is the cost of 1 ton blast-furnace coke.*

The electrical energy required for heating the charge in the electric furnace for the production of 1000 kg iron is $1000 \times 24 \div n$ hp -hours, if n is the number of kilograms of iron produced by 24 hp-hours. To this must be added 700 (Catani) or 400 (Neumann) hp-hours (which are less available from the electric-furnace gases than for the blast-furnace gases). If now the cost of the hp-year is x and the number of working hours in 360 days is 8640, the total cost of electric energy which is to be charged against the electric furnace in comparison with the blast furnace is:

$$\left(\frac{1{,}000 \times 24}{n} + 700\right)\frac{x}{8{,}640}$$

if we take Catani's figure 700, or

$$\left(\frac{1{,}000 \times 24}{n} + 400\right)\frac{x}{8{,}640}$$

if we take Neumann's figure.

By putting the saving in coke against the expense of electrical energy, we get the conditions under which the electric furnace and the blast furnace are just commercially equivalent:

$$(1) \quad y = x\left(\frac{4}{n} + 0.12\right)$$

if we accept Catani's figure of power surplus from gases, and

$$(2) \quad y = x\left(\frac{4}{n} + 0.07\right)$$

if we use Neumann's corrected figure.

From these formulas we get the following two tables, giving the minimum price of electrical energy x, for which competition with the blast furnace becomes possible. It will be seen that the considerable difference in the surplus power figures of Catani and Neumann does not lead to very different results in the values of x.

From Equation (1) (Catani's surplus power figure), we get this table: Coke cost is y.

	y = Price of coke		
n	y = $4.00	$6.00	$8.00
6 kg	x = 5.12	7.67	10.25
8 kg	6.40	9.60	12.80
10 kg	8.00	12.00	16.00
12 kg	9.00	13.50	18.00

From Equation (2) (Neumann's surplus power figure), we get the next table:

	y = Price of coke		
n	y = $4.00	$6.00	$8.00
6 kg	x = 5.40	8.10	10.80
8 kg	7.00	10.50	14.00
10 kg	8.50	12.75	17.00
12 kg	10.00	15.00	20.00

A consideration of the capital investment is instructive. For a daily output of 400 tons of pig iron $n = 8$ (which, under present conditions, represents pretty good electric-furnace practice), there are required 50,000 or 55,000 hp in the power house, or 70,000 hp with reserves. If the cost of the plant is figured at $40 per hp, this gives a first cost of $2,800,000.

Finally the balance sheet of the materials involved in the process, as calculated by Catani for producing 1000 kg pig iron will be given:

	Blast Furnace.	Electric Furnace.
Raw Materials.		
Ore	1,920 kg	1,920 kg
Blast	4,997 "	....
Lime	500 "	395 "
Coke	1,113 "	335 "
Electrodes	....	20 "
Totals	8,530 kg	2,670 kg
Products.		
Pig iron	1,000 kg	1,000 kg
Slag	745 "	606.5 "
Gas	6,799 "	1,063.5 "
Totals	8,533 kg	2,670 kg
Calorific value of gas	4,121,000 cal.	1,333,000 cal.

Density and Coherence of Electrolytic Deposits.

That the density and coherence of an electrolytic deposit can be greatly improved by the addition of a very small quantity of an "addition-agent" like glue, to the electroyte, has been known since Betts successfully employed this trick in his lead refining process. R. P. Jarvis and E. F. Kern (*School of Mines Quarterly*, Vol. 30, No. 2) have studied in detail the effect of the presence of certain "addition-agents" upon the density and the coherence of electrolytically deposited copper, lead and silver.

They find that fluo-silicate electrolytes of lead, copper and silver give more coherent deposits than those formed in the nitrate electrolytes of lead or silver, or in the sulphate or chloride electrolytes of copper.

The lead deposit is improved by the addition of 1 part tannin to 200 parts of an almost neutral electrolyte of lead nitrate, or 1 part to 5000 parts of a lead fluo-silicate electrolyte.

The copper deposit is improved by the addition of tannin to copper sulphate or copper fluo-silicate electrolytes. With a cuprous chloride electrolyte tannin has no effect.

Silver deposits from silver nitrate or silver fluo-silicate solutions are improved by the addition of 1 part of gelatine to 10,000 to 14,000 parts of solution.

Dr. Kern will present a paper on this subject before the American Electrochemical Society. This will be reported in full in this journal.

*As a matter of fact, this is really an understatement of the case of the electric furnace, since the fuel required as reducing agent must be good coke in the blast furnace, and may be charcoal or cheap peat coke in the electric furnace. Although the weight in both cases is the same, there may be a difference in price and this should be added to the above figure.—Ed.

The Production of Pig Iron at the Electric Furnace and the Industrial Utilization of Pyrite Residue.

BY F. E. CARCANO.

With reference to the notable article of Mr. H. Harden and the editorial note on this subject, which appeared in the January number of this journal, I offer the following considerations:

Admitting as indisputable the principle that at the present time the electric furnace cannot generally compete with the blast furnace in the production of pig iron, I desire to demonstrate a particular though interesting case in which the electric furnace can well hold its own against the blast furnace.

In Italy the acid industry is well developed. This industry abandons as a residue almost from two to three hundred thousand tons yearly of pyrite ash, and this refuse, accumulated in many years, is actually available.

These residues of pyrite contain from 46 per cent to 57 per cent of metallic iron, with about 2 per cent of sulphur. The refuse is generally silicious, but in some cases the matrix contains considerable lime.

There are, therefore, about 100,000 tons of iron yearly unutilized, quite a considerable quantity, especially in Italy, where iron ores are scarce and practically found only in one locality (on the island of Elba).

The abandonment of such an important stock till the present time can only be explained by two reasons. Technically it may have appeared doubtful whether a material so rich in sulphur and in such a powdered form could be treated with good results in the blast furnace. There is no mine of good iron ore near these deposits with which the refuse could have been mixed, as is done in other European countries. Further, these deposits are nearly all found in the interior, far from the places where coke (which comes from abroad) is cheap enough to render iron production economical.

But close to these refuse heaps water power is available under good conditions. Naturally, the opportunity for the electric furnace appeared good. Certainly I do not believe to be the only one to have studied the utilization of such refuse by means of the electric furnace; but having been able to apply my electric furnace and my process, thanks to the help received from the "Società Unione Italiana Concimi," in experiments which lasted many months, and with furnaces of 400 hp, I think it will be of interest to give some results and to discuss the matter especially from the economic point of view.

In the locality where the experiments were carried out (in Lombardy) the kw-hour costs about 0.009 franc (0.18 cent). Hard coke as generally used in blast furnaces costs in the Italian ports 45 francs ($9) per ton, or would cost in the above-named locality 50 francs ($10) per ton. But our experiments have shown that we could use in our electric furnaces small coke and coal dust, which can be had in large quantities and at such low prices as 12 and 20 francs ($2.40 and $4) per ton.

As for the pyrite ash we will give them a conventional price, delivered at the furnace, of 5 francs ($1) per ton. I say a conventional price, since in reality even to-day in many places this residue can be obtained free of charge.

As to the means used to utilize the iron contained in the refuse, I will mention two types of furnaces which were alternatively used:

A. First, a furnace with two groups of electrodes connected in series, with a carbon hearth and lining of magnesia and with free escape of gas and flame.

B. Second, an arc furnace with a vaulted roof, of special material, very low and completely closed, so as to permit complete recovery of the gases.

The first type of furnace was much easier for experiments, but for a permanent application the second type is more economical. While the life of the vaulted roof is much longer than in analogous designs and while the energy consumption is equal to that in a furnace of the first type, we have the advantage of a smaller waste of the electrodes and we are able to recover all the evolved gases.

To obtain good pig iron from a material so rich in sulphur, both types of furnaces we found to be of good service.

What is essential and somewhat difficult is to find the correct mixture of fluxes for each sort of pyrite.

It is wrong to hold that the high temperature of the electric furnace is sufficient to obtain a satisfactory desulphurization. A pig iron obtained from a mineral containing 2 per cent of sulphur will rarely contain less than 0.4 per cent of sulphur if treated with fluxes calculated by ordinary methods, unless the operation is very much extended, which evidently means a waste in energy. Nor is it sufficient to add a great quantity of lime, as it would again require a rather inconveniently great amount of energy to maintain it in the fluid state. Therefore it is necessary to make a slag with multiple bases, the components and proportions of which must be studied for each type of mineral to be treated.

In this manner it is possible to obtain pig iron of such composition as will be discussed later, with a cost of fluxes of 3 to 4 francs (60 to 80 cents) per ton of pig iron.

The amount of energy required, as has been shown in many experiments, is, in the average, 2200 kw-hours per ton of pig iron, or 3.8 tons per kw-year of 350 working days. This figure is practically the same as has been obtained in other experiments with the usual iron ore.

As to the consumption of the electrodes, with the furnace of type A it amounted to 20 to 24 kilograms per ton of pig iron, costing about 7 francs ($1.40), but with the furnace type B this cost is reduced to almost one-half.

The cost of labor, maintenance, etc., of plants of medium size comes very close to the figures of the Canadian Commission, namely, the cost of labor about 5.50 francs ($1.10) per ton of pig iron, and the cost of maintenance about 4.50 francs (90 cents). This naturally refers to plants of 20,000 tons a year.

To sum up, the cost per ton of pig iron in the electric furnace under the above-mentioned conditions would be with a furnace of type A:

	Francs.
Mineral (pyrite ashes, 2000 kg)	10
Small coke and dust, 450 kg	9
Divers fluxes and added material	4
Electrodes, 22 kg	7
Maintenance	4.50
Labor	5.50
Electrical energy (2200 kw-hour)	19.80
Total	59.80
Or	$11.95

With a furnace of type B it is possible to reduce this sum by two or three francs in the cost of the electrodes.

In the same locality and with the same original material, what would be the cost of making pig iron at the blast furnace?

	Francs.
Mineral (pyrite ashes, 2000 kg)	10
Hard coke, 980 kg	49
Divers fluxes	4
Labor	4
Compressed air	1.50
Maintenance	4
Total	72.50
Or	$14.50

As will be seen, the balance is directly in favor of the electric furnace. But we do not need to insist on this point alone. It may be emphasized that pig iron of extra good quality was obtained, as our experiments have demonstrated, *without any preliminary preparation of the raw material.* With the blast

furnace the pyrite ashes demand a certain preparation, the cost of which I think would be at least 3 francs per ton of mineral —that is, 6 francs ($1.20) per ton of pig iron.

To give an idea of the economical situation, I will mention that pig iron of medium quality costs at the Italian ports 80 to 82 francs ($16 to $16.40), and 6 to 7 francs ($1.20 to $1.40) more in the interior.

As to the possibility of the blast furnace to utilize the gases which are evolved as a source of power, I wish to emphasize that this is of small importance in a country where energy costs so little as mentioned above.

Nevertheless, it has been seen that in electric furnaces of type B all the evolved gas can perfectly well be recovered, and our studies are now actually directed toward the utilization of this gas, not as a source of energy, but as a reducing agent and for preheating the material, permitting thus to obtain an economy of coal and energy which I estimate to be about 5 to 6 francs ($1 to $1.20) net.

Let us now examine the kind of pig iron obtained and the applications to which it can be put.

Pig Iron for the Foundry.

In a series of experiments pig iron of the following composition was obtained. It is well adapted for the foundry:

S.	Ph.	Mn.	Si.
0.046	0.063	2.23	3.83
0.058	0.075	2.17	4.46
0.039	....	3.20	1.72

We have also made a long series of experiments to solve the problem of utilizing this pig iron directly—that is, using the pig iron as it comes out of the electric furnace to make castings (especially tubes, pillars, ornaments, etc.), and with special modifications of the construction of the furnace even this result was obtained.

Pig Iron for Steel.

Another series of experiments gave us pig irons of the following types:

S.	Ph.	Mn.	Si.
0.031	0.070	1.054	5.68
0.015	0.073	2.26	6.70
0.026	0.016	2.54	5.70

Pig iron of this kind would be perfect for acid open-hearth and Bessemer plants. But it would be wrong to produce such pig iron in electric furnaces and then to remelt it.

In the locality where we are working at the present time, where the energy is cheap, it would be advisable to charge such pig iron, while still in its fluid state, into a second electric furnace to be converted into electric steel of high value.

With respect to other firms, which produce electric steel, an advantage would be gained in saving the expense of remelting the pig iron, which has to be done before it is sent into the electric furnace for the production of the steel.

We have also produced some spiegel and silico-spiegel of low percentage of the following compositions:

	S.	Ph.	Mn.	Si.
Spiegel	0.015	0.060	11.25	3.30
Silico-spiegel	0.020	0.065	13.66	8.90

It is not necessary to speak here of the production of high-percentage alloys in our furnaces, as this has nothing to do with the problem of the production of pig iron from pyrite residues.

Instead, I wish to make a remark of a general character.

It is usually stated that the chemical reactions which occur in the electric furnace are identical with those which occur in the ordinary blast furnace. This is at least not exact; the more elevated temperature of the electric furnace and many other reasons make it easier to incorporate silicon, manganese, chromium, etc., with the pig iron, all of these bodies having a high point of volatilization, while phosphorus and sulphur and other volatile bodies are more easily eliminated.

For example, to obtain in the blast furnace a pig iron with 25 per cent silicon is relatively difficult, but it is easy in the electric furnace.

Reversely, in general an operator at first finds it very difficult to obtain pig iron with less than 7 or 8 per cent silicon if the ore is acid.

To produce a spiegel with 12 per cent to 14 per cent of manganese or a silicious spiegel does not require, according to our experiments, more than a slight rise (less than 10/100) in the energy, as compared with common pig iron, while the value of the product is considerably higher.

For example, a spiegel of 14 per cent costs 36 francs ($7.20) more than the pig iron, while the cost of the manganese ore (taking into account the losses) costs about 14 francs ($2.80).

In general terms, therefore, it is necessary to keep in mind the following points when comparing the electric furnace and the blast furnace:

(1) It is possible to use directly in the electric furnace impure ores which cannot be so used in the blast furnace.

(2) It is possible to use in the electric furnace coals of various coals of various kinds which cannot be used in the blast furnace.

(3) It is easy to make castings direct from the electric furnace, and it is also practical to convert on the spot rapidly the pig iron generated from a first furnace into special electric steel in a second refining furnace, while it is difficult to find a blast furnace in a locality where electric energy is cheap.

(4) In the electric furnace it is easy to incorporate with the pig iron silicon, manganese and other elements which raise its value and to eliminate those which diminish it.

This is true for every case in which pig iron is produced from ore.

As to the special problem of the utilization of the pyrite ashes for the production of pig iron, I have here described my investigations, thinking it possible that there may be other countries where the conditions are similar as in Italy—that is, lack of coal or iron ore, but plenty of water power and plenty of pyrite residues.

Societa Elettrochimica, Monza, Italy.

The Electrochemistry of the Solution of Gold in Potassium Cyanide.[1]

By John B. Ekeley and Arthur L. Tatum.

In 1893 McLaurin[2] proved definitely that gold will dissolve in potassium cyanide solution when there is oxygen present, but that, if no oxygen is contained in the cyanide solution, the gold remains unacted upon. From pure hydrocyanic acid and potassium hydroxide dissolved in water freed from air by long boiling, McLaurin prepared a solution of potassium cyanide. A Dumas bulb was partly filled with this solution, a strip of pure gold was placed in the neck of the bulb, and, while the solution was boiling, the neck was sealed. The gold was allowed to remain in the solution for 24 hours, the gold losing in weight 0.0002 grm. The gold was then allowed to remain in contact with the same solution in the presence of air for 24 hours, during which time it lost 0.0083 grm. This is the best experimental evidence we have that gold requires oxygen for its solution in potassium cyanide.

Although other investigators took up the study of the solubility of gold in potassium cyanide, little of any great value in a theoretical way was brought forward until Christy[3] took the subject up from an electrochemical standpoint, his work being published in 1902.

Christy made use of an Au, KCN, Hg_2Cl_2, Hg couple, measuring the electromotive force and finding that the positive current flows in the cell from the gold electrode to the mercury,

[1] A paper read at the fourth annual meeting of the Western Association of Technical Chemists and Metallurgists, Boulder, Colo., Jan. 6, 1909. From the *Western Chemist and Metallurgist*, the organ of the Association.

[2] *Journal of the Chemical Society of London*, Vol. 63, page 727.

[3] *Elektrochemische Zeitschrift*, Vol. 8, page 227.

gold going into solution and mercury being deposited. He then suggested that, should an "oxygen electrode"—that is, platinized platinum saturated with oxygen gas—be substituted for the calomel electrode, the gold would go into solution in the cyanide and the platinum would receive the same electrical charge that he found in the case of the mercury.

In support of this he performed the following experiment: A strip of gold was suspended in a solution of potassium cyanide that had been saturated with oxygen. A second strip of gold was suspended in a similar solution freed from oxygen by boiling and subsequently protected by a layer of oil. The two solutions were connected by means of a liquid bridge, and the two gold strips by means of a wire and galvanometer. Gold dissolved in the oxygen-free solution and a current was shown by the galvanometer to be flowing in the solutions from the oxygen-free solution to that containing the dissolved oxygen.

The following explanation of the phenomenon has occurred to us: Christy's cell is analogous to the simple cell constructed in the same manner by substituting zinc in sodium sulphate for gold in oxygen-free cyanide, and copper in sulphuric acid for gold in oxygenated cyanide. Here the current flows in the solutions from the zinc to the copper, zinc dissolving in one solution and hydrogen being liberated on the copper. The zinc dissolves in the absence of acid just as in Christy's cell the gold dissolves in the absence of oxygen.

In the zinc-copper cell the solution pressure of the zinc drives zinc ions into the solution, the hydrogen ions in the other solution being thus forced out, giving their charges to the copper, with production of a current outside the cell from copper to zinc. In Christy's cell, the gold on account of its solution pressure sends gold ions into the solution. Hydrogen ions in the oxygenated cyanide vessel (due to the slight ionization of water into $H^{\cdot}$ ions and OH' ions) tend to be forced out just as in the zinc-copper cell, but this does not occur. The dissolved oxygen sends, by virtue of its solution pressure, oxygen ions, O'', into the solution. These O'' ions with the $H^{\cdot}$ ions form OH', so that the cell acts like a bichromate cell or any other oxidation cell, instead of like a simple zinc-copper couple. The OH' ions thus left in the solution form with the $K^{\cdot}$ ions dissociated KOH.

In view of the above considerations, it seemed interesting to us to set up an Au/KCN/O — Pt couple. As expected gold dissolved rapidly in the cyanide, the rate varying with the concentration of the cyanide, and the concentration of the oxygen in the oxygen electrode, the current passing in the couple from gold to oxygen. Solubility determinations are needless and impossible on account of the difficulty of excluding air from the cyanide, and of the variability in the potential of the oxygen electrode.

If it were possible to supply oxygen to the platinized platinum at a high enough speed and at the same time exclude all air from the cyanide solution (other things being equal, such as physical condition of the gold, etc.), the solubility would undoubtedly be directly proportional to the current, according to Faraday's law. As a matter of fact, the physical condition of the gold varying and causing a varying occlusion of oxygen on its part, the oxygen held in solution by the cyanide, and the varying amount of oxygen occluded by the platinized platinum undoubtedly cause the gold to dissolve at a rate not proportional to the current flowing through the cell. Hence the solubilities indicated in the following table are not to be considered more than fair approximations:

Strength of KCN.	Time.	Au Dissolved.	
0.05%	2 hr.	0.0219 grm.	Circuit closed.
0.05%	2 hr.	0.0036 grm.	Circuit open.
0.1 %	2 hr.	0.0307 grm.	Circuit closed.
0.1 %	2 hr.	0.0055 grm.	Circuit open.
0.15%	1 hr.	0.0193 grm.	Circuit closed.
0.15%	1 hr.	0.0033 grm.	Circuit open.

We also measured the potentials of gold in varying concentrations of cyanide against the oxygen electrode, with results which agree with the measurements of Christy and others made against the normal calomel electrode:

Strength of Solution.	Gold Potential.
0.1 %	0.12 volt.
0.15%	0.14 volt.
0.65%	0.21 volt.
0.8 %	0.22 volt.
1.0 %	0.29 volt.

The equation for the solubility of gold in potassium cyanide, often called Elsner's equation, is

$$4\,Au + 8\,KCN + 2\,H_2O + O_2 = 4\,K\,Au\,(CN)_2 + 4\,KOH$$

The gold dissolves on account of the formation of innumerable short-circuited gold-oxygen cells. The gold sends 4Au ions into the solution by virtue of its solution pressure, and at the same time the dissolved oxygen sends $2O''$ ions into the solution by virtue of its solution pressure. The $4Au^{\cdot}$ ions react with the $8CN'$ ions of the dissociated KCN, forming $4Au\,(Cn)_2'$ ions, and the $2O''$ ions react with $2H^{\cdot}$ (which are present from the dissociation of $2H_2O$ molecules into $2H^{\cdot}$ and $2OH'$), forming $2OH'$ ions. Thus the ions present before solution are

$$4Au^{\cdot} + 8K^{\cdot} + 8CN' + 2H^{\cdot} + 2OH' + 2O''$$

and after the reaction

$$8K^{\cdot} + 4Au(CN)_2' + 4OH'$$

or written in the form of an equation,

$$4Au^{\cdot} + 8K^{\cdot} + 8CN' + 2H^{\cdot} + 2OH' + 2O'' = 8K^{\cdot} + 4Au(CN)_2' + 4OH'$$

Oxygen need not necessarily be the carrier of the four negative charges required. Any substance capable of furnishing these charges would cause gold to dissolve in potassium cyanide, or any mechanical means of producing these four charges would have the same effect. In this latter case the equation would be

$$2Au^{\cdot} + 4K^{\cdot} + 4CN' + 2H' + 2OH' = 4K^{\cdot} + 2Au(CN)_2' + 2OH' + 2H$$

and gaseous hydrogen would be liberated from the cyanide solution as the solution of the gold proceeded.

Brom-cyanogen added to a potassium cyanide solution is a very effective gold solvent. The reaction is

$$Au_2 + 3KCN + Br\,CN = 2K\,Au\,(CN)_2 + K\,Br.$$

Considered electrochemically the reaction is as follows:

The solution pressure of the gold sends $2Au^{\cdot}$ ions into the solution while the solution pressure of the cyanogen bromide sends a Br' ion and a CN' ion into the solution. The $2Au^{\cdot}$ ions react with the $4CN'$ ions, forming $2Au(CN)_2'$ ions, so that the equation would be written

$$2Au^{\cdot} + 3K^{\cdot} + 3CN' + Br' + CN' = 2K^{\cdot} + 2Au(CN)_2' + K^{\cdot} + Br'.$$

It should therefore be possible to set up a cell in which gold and solid cyanogen bromide were the electrodes and potassium cyanide the electrolyte. The current would flow in the cell from the gold to the cyanogen bromide, both being consumed, just as in the gold-oxygen cell, the current flows in the cell from the gold to the oxygen, both being consumed.

Chemical Laboratory, University of Colorado.

W. H. Wahl.

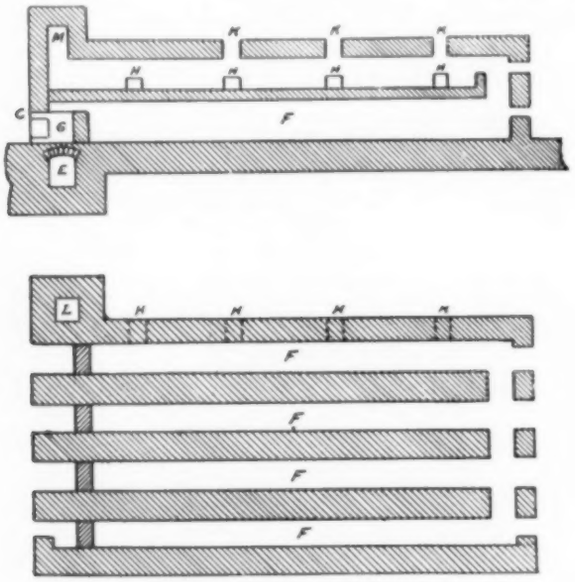
While going to press we learn of the death of Dr. W. H. Wahl, a noted metallurgist and writer on scientific subjects and for many years secretary of the Franklin Institute in Philadelphia, on March 23, at the age of almost 60 years.

Dr. Wahl, together with Professor Greene, was one of the first to study the use of aluminium as a reducing agent for refractory oxides, and produced in this way chromium and other metals free from carbon. But at that time the price of aluminium was so high that this method was only of scientific interest. Dr. Wahl also wrote a well-known book on electroplating. He was one of the founders of the American Electrochemical Society.

The Use of Producer Gas in Chemical and Metallurgical Industries.

By Dr. Oskar Nagel.

In an article in the January issue (page 29) I have discussed the design of gas-fired furnaces for various industrial purposes.



FIGS. 1 AND 2.—CHLORIDIZING ROASTING FURNACE.

In the present article I will discuss specially the use of producer gas in the chemical industries.

In the manufacture of sulphuric acid (chamber process) there is little difficulty in obtaining 95 per cent acid in the platinum vessels, by the use of direct fire. If, however, 96 per cent acid is to be obtained, the use of producer gas is preferable, and the latter must necessarily be used for the economical and continuous production of 97 to 98 per cent acid, as with direct fire the proper heat cannot be kept up. The gas-fired furnaces used for this purpose are of the usual reverberatory type, the passage of the products of combustion being arranged on the counter-current principle.

For chloridizing roasting producer gas is commonly used in Europe. Figs. 1 and 2 show such a furnace. From the producer, which is not shown in the cut, the gas goes through sewer *E* to channels *G* and *F*, then over the charge through flue *M* to stack *L*. The combustion air enters at *c* and, if necessary, also at the other end of the furnace. The material is charged through *K* and worked through doors *H*.

Another construction of a furnace for chloridizing roasting is shown in Fig. 3. The gas goes through *f* and *g*, the air enters through *h*; *l* is a working door.

A German furnace for melting soda is shown in Figs. 4, 5 and 6. Fig. 4 shows one-half of a furnace on section *C D*, Fig. 5 section *E F* and Fig. 6 one-half on section *A B*; *a* is the hearth with the working doors *f*, *B* the flue, e the air regenerator, *c'* the gas regenerator. On account of the flue dust, vertical walls are used in these regenerators instead of the ordinary checker work. In order to remove the flue dust, the cover *d d* is lifted up and the dust pushed down into pits *e*, after removing a few bricks.

The use of producer gas in zinc smelting is one of its most important applications. A typical construction, as used near Freiberg, is shown in Fig. 7 (section *I K L M*), Fig. 8 (section *A B C D*), Fig. 9 (section *E F G H*) and Fig. 10 (section through reversing valves at *M N*); *a a* are the muffles, *b b b*

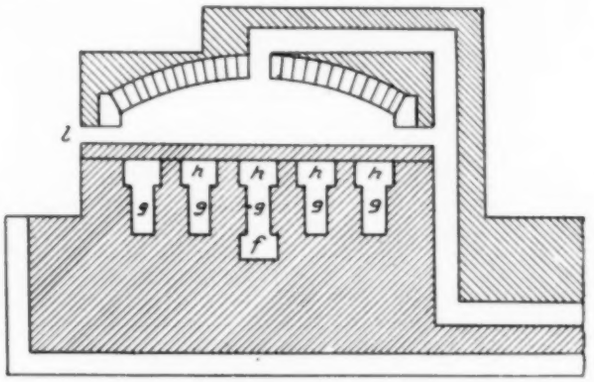
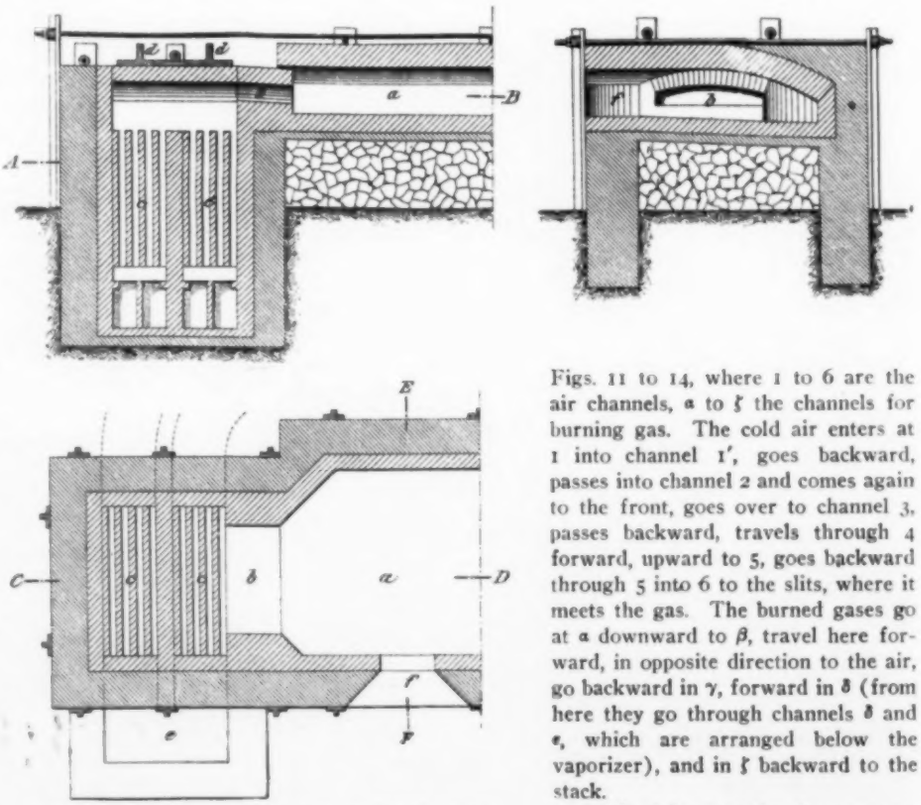


FIG. 3.—CHLORIDIZING ROASTING FURNACE.

the air slits, *b'b'b'* the gas slits, *c c* the air regenerators, *c'c'* the gas regenerators, *i i* the gas channels, *i'i'* the air channels, *g* the gas valve, *g'* the air valve, *k k* the pits for getting at the regenerators in case of necessary repairs, *h* is the main flue, *m m* the walls separating the prolongs, *o* the cleaning cover for the gas valve, *p* the air slide and *n* a cover, which is removed for changing the position of the valve levers.

In heating gas retorts with producer gas a saving of over 25 per cent is effected. The Schilling-Bunte furnace is shown in



FIGS. 4, 5 AND 6.—FURNACE FOR SMELTING SODA.

Figs. 11 to 14, where 1 to 6 are the air channels, α to ζ the channels for burning gas. The cold air enters at 1 into channel 1', goes backward, passes into channel 2 and comes again to the front, goes over to channel 3, passes backward, travels through 4 forward, upward to 5, goes backward through 5 into 6 to the slits, where it meets the gas. The burned gases go at α downward to β, travel here forward, in opposite direction to the air, go backward in γ, forward in δ (from here they go through channels δ and ε, which are arranged below the vaporizer), and in ζ backward to the stack.

Gas-fired furnaces for the regenera-

tion of bone-black have been in successful use since 1873. This process of regeneration requires great exactness and causes considerable expense, as the application of a uniform product, which can only be obtained by uniform temperature, is very important. By using producer gas, the cost of labor is greatly reduced, since, with a fair grade of fuel, the producer works practically automatically.

With gas-firing the result of the process does not depend upon the intelligence of the workingman in charge; the temperature is easily regulated, and a great saving in fuel is effected. From time to time fresh bone-black is charged and at the same time a corresponding quantity of the regenerated product discharged.

There are in use furnaces with vertical or inclined cast-iron or fire-clay cylinders (retorts) of circular or oval cross-section of a diameter of 5 to 20 inches. The capacity of a furnace per 24 hours varies from 2½ tons to 15 tons.

There is no difficulty in applying gas-firing to furnaces of this kind. Figs. 15 and 16 show the firing of a furnace with 14 cylinders, with a capacity of 6 tons of regenerated bone-black per 24 hours.

The cylinders are arranged in two rows (seven in a row). In a similar way 12 to 15 cylinders can be set in one row. Between the two rows there is an open space of about 30 inches, which up to two-thirds of the height of the cylinders is reduced by two thin fire-bick walls to about 18 inches.

The gas from the producer goes through channel *g*, is regulated at *R* and passes into the furnace proper through an arch provided with a number of outlet slits. The air also enters through slits provided in this arch, as shown in Fig. 16 by dotted lines. The air is preheated by the sensible heat of the incandescent, regenerated bone-black, and travels parallel to the gas.

The size and arrangement of the slits depend upon the capacity of the furnace. The flame rises between the two brick walls and then falls downward, playing around the cylinders. The products of combustion leave through channels *f* to flue *F*. On their way they come in contact with the material, since the cylinders are perforated, thereby drying and preheating same and increasing the economy of operation.

A direct-fired furnace can be easily changed for operation with producer gas.

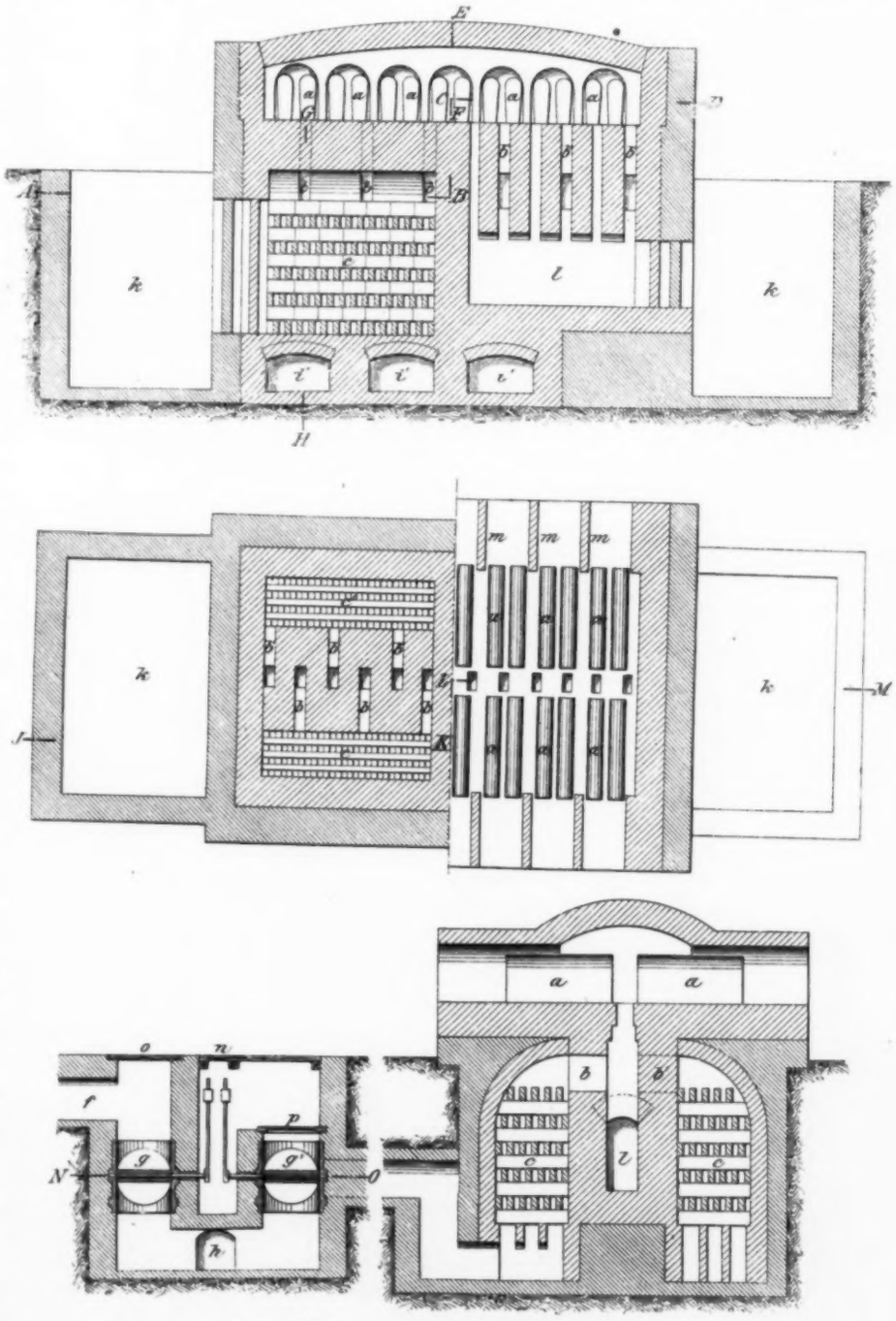
For observing the temperature peep-holes *r* are provided as shown in Fig. 15.

Two or more furnaces can be supplied with gas from one producer.

Electric and Fuel Furnaces.

By F. Louvrier.

It is easy to foresee that within the next few years an important revolution will take place in the methods now used for the treatment of some ores, or, to be more exact, in the means employed to obtain them. We will speak of the substitution of



FIGS. 7, 8 AND 9.—SECTIONS OF ZINC FURNACE.

electrical energy, as a thermic agent, for the usual combustibles, coal, coke, petroleum, etc.

At the present time electricity has completely conquered the metallurgy of aluminium; it is used in the manufacture of steel-alloys; it is about to absorb the manufacture of high-grade steels; its use in the treatment of zinc ores is but a question of a few months.

Such rapid progress enables one to forecast that at no distant

a date electricity will also be applied to the treatment of other ores, iron, copper, lead, gold, silver, tin, to speak only of the metals which give rise to important exploitation.

It is consequently a matter of interest to trace the causes of this progress, the superiority of the electric furnace over those now employed.

Apart from special cases (the manufacture of aluminium, for instance) the electro-metallurgical furnace has no other object than to substitute heat produced electrically for heat produced from fuel.

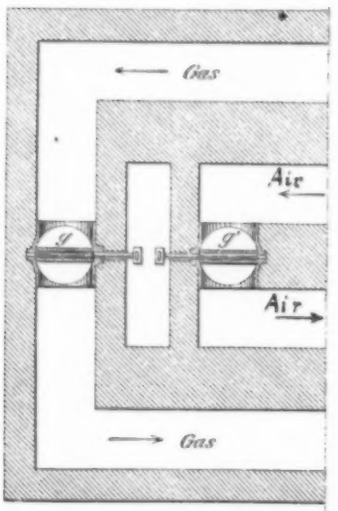


FIG. 10.—SECTION THROUGH REVERSING VALVES.

It is proper, therefore, at first to make a comparison between the two types, electric furnace and ordinary furnace, from the simple caloric point of view. In the ordinary furnaces the use of fuel always demands a blowing-in of air, of more or less intensity. If, in some cases, the use of this air involves inconvenience (iron, copper, lead, gold and silver), it is not so in many others, for example, when the ores treated are oxidizing (tin) or very oxidizing and volatile (zinc) at their temperature of reduction.

Hence, there are several types of metallurgical furnaces using combustibles—those in which the ores treated are in direct contact with the fuel, and others, in which the ores are more or less completely separated from the fuel or from the products of combustion.

It is evident that the thermic efficiency of the first type is greatly superior to that of the second.

In the electric furnace no combustion takes place; there is consequently no oxidizing action, and it becomes possible to treat the more oxidizing and volatile metals (zinc) by putting them into direct contact with the source of the heat.

With this explanation we shall begin the comparison between the two types of furnaces, considering the most favorable case for the ordinary furnaces, namely, that of direct firing.

Direct-Fired Furnaces.—If we burn in one of these furnaces a molecular volume (12 grams) of pure carbon the reactions of combustion are reduced to one for perfect combustion.

$$C + O_2 + 4\,N_2 = CO_2 + 4\,N_2,$$

producing a molecular volume of carbonic acid with an evolution of 97.6 Calories.

The oxygen necessary for this combustion is one molecular volume. But as this oxygen comes from the air, it is consequently accompanied by a volume of nitrogen, which practically may be considered as four times the volume of the oxygen, i.e., four molecular volumes, as indicated by the formula of reaction given above.

The result is that the smoke escaping from the furnace is composed, at least, of one molecular volume of carbonic acid and four molecular volumes of nitrogen.

Without counting the heat lost in radiation, the heat used in the furnace is the difference between that produced by the combustion of the carbon and that carried away by the smoke and lost.

This latter can be easily calculated by the formula of M. M. Mallard and Le Chatelier:

$$Q = a\,\frac{T - t}{1000} + b\,\frac{T^2 - t^2}{1000^2}$$

which gives the heat of heating the gases per molecular volume, between two temperatures t and T under constant pressure, a being a constant common to all gases and equal to 6.5 and b a constant which has a different value for each gas, namely, 0.6 for the nitrogen and the oxygen, and 3.7 for the carbonic acid.

Applying this formula to the case of ordinary coke furnaces used in the treatment of cupper, lead, gold, and silver ores, furnaces in which the normal temperature may be estimated at 1150° C. above the ambient temperature, we obtain for the heat of heating, per molecular volume, of nitrogen and oxygen at 1150° C., 8.65 calories, and for the carbonic acid 14.77 calories.

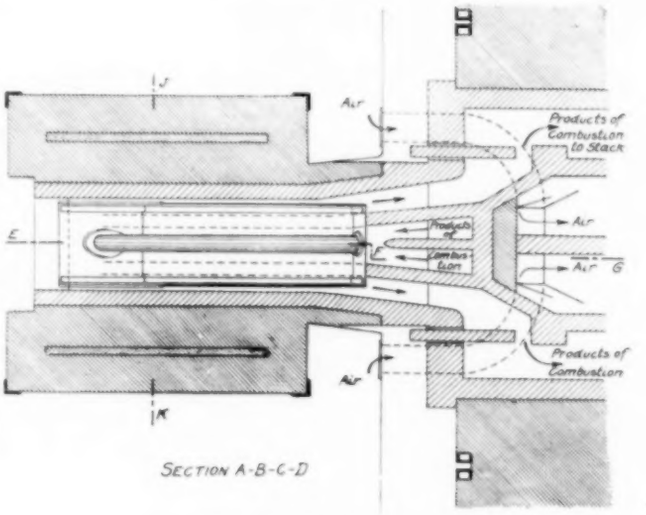


FIG. 11.—SCHILLING-BUNTE FURNACE.

Consequently the quantity of heat carried away by the smoke in these furnaces is not less than:

$$8.65 \times 4 + 14.77 = 49.37 \text{ calories.}$$

This result is the one obtained by an absolutely theoretical combustion, supposing that the carbon used is chemically pure,

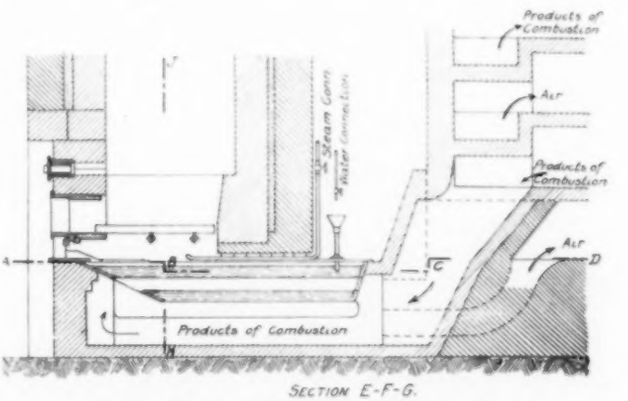


FIG. 12.—SCHILLING-BUNTE FURNACE.

that the quantity of air injected into the furnace is strictly the quantity necessary for combustion, and that the carbon is totally burned.

But these three conditions are never realized in practice. The coke ordinarily contains about 9 per cent of incombustible impurities; a part of the coke (3 per cent as a minimum) is carried away by the smoke, under the form of particles (black smoke) without being burned, and there is always an excess of air injected.

This excess of air, even under very good practical conditions, is not less than 10 per cent, and in many instances it is as high as 60 per cent. Under good average ordinary conditions it may be calculated at 20 per cent minimum.

The result practically is that only $100 - (9 + 3) = 88$ per cent

of the weight of the coke is furnishing the heat, and that, therefore, the quantity of heat produced by the combustion of 12 grams of coke is not more than:

$$97.6 \times 0.88 = 85.88 \text{ calories,}$$

and that the quantity of heat carried away by this smoke is:

$$8.65 \times 4 \times 1.20 + 8.65 \times 0.20 + 14.77 \times 0.88 = 56.25 \text{ calories.}$$

Consequently the quantity of heat utilized in the ordinary furnaces employed for the treatment of copper, lead, gold and silver ores, and resulting from the combustion of 12 grams of coke is:

$$85.88 - 56.25 = 29.63 \text{ calories,}$$

which corresponds to a useful power of:

$$\frac{29.63 \times 1000}{12} = 2469 \text{ calories}$$

per kilogram of coke consumed, without taking into consideration, as stated, the losses by radiation.

In an electric furnace of the resistance type, if we also exclude these losses, the electrical energy is entirely converted into heat, so that one electric horse-power per year gives

$$\frac{75 \times 3600 \times 24 \times 365}{419} = 5,645,000$$

useful calories, and, therefore, is equivalent to

$$\frac{5,645,000}{2469} = 2285 \text{ kilograms}$$

of coke burned in the ordinary furnaces.

As the radiating surface of an ordinary furnaces is, at least, five times that of an electric furnace of the same production, and, as in the former, the maximum temperature is produced near the walls of the furnace, while in the latter this maximum temperature is obtained in the center of the materials to be treated, the certainty is that the losses by radiation are, at the least, five times greater in the ordinary furnaces than in the electric furnace.

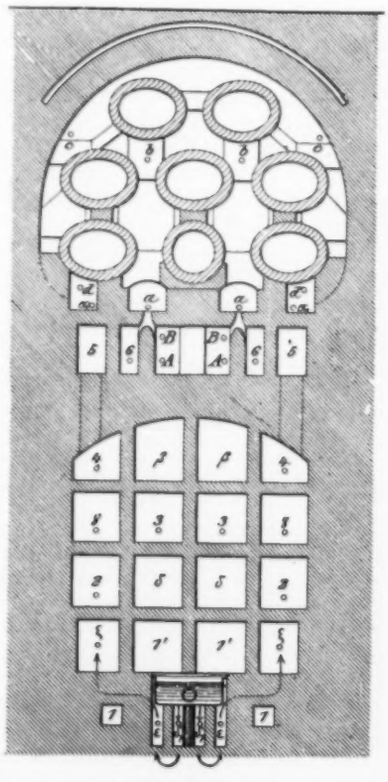


FIG. 13.—SCHILLING-BUNTE FURNACE.

Taking into account these losses, we arrive at the following conclusion:

One electric horse-power per year is equal to 2500 kilograms of coke consumed in the ordinary furnaces.

Let us make a comparison between the costs of the two thermic agents employed to obtain the same result.

At Livet, France, electric energy is rented at a cost of 25 francs per horse-power year, i. e., at less than $5. Dr. Haanel, Director of Mines in Canada, assumes the possibility of a cost of $4.50 in his country; at Nottoden, Norway, electrical energy is rented at the rate of 23.60 francs per horse-power per year, i. e., at less than $4.60. In Mexico we know of numerous waterfalls capable of furnishing electrical energy at a price that will not exceed $5. Taking these figures, $5 would not be an unfair price under favorable conditions; nevertheless, and with the object of understanding the price of electrical energy, we assume the cost of one horse-power to be $6 and we fix at $5 the cost of one ton of coke delivered at the mines, in countries where fuel is cheap (United States, most countries in Europe, etc.).

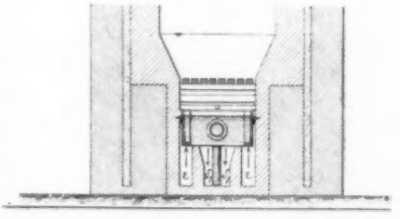


FIG. 14.—SCHILLING-BUNTE FURNACE.

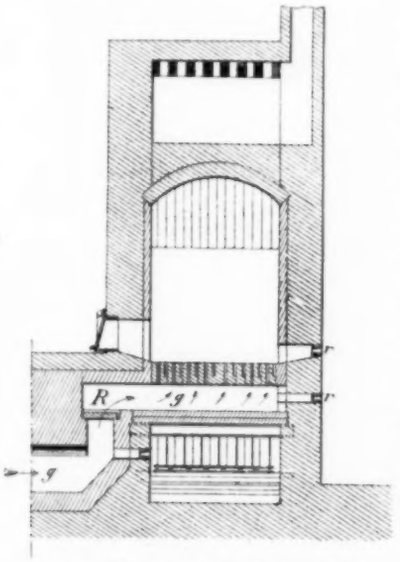


FIG. 15.—BONE-BLACK FURNACE.

Under these conditions, where electrical energy is very cheap, $6 in electrical energy is equivalent to: $5 \times 2.5 = \$12.50$ of coke; i. e., the employment of the electric furnaces is $12.50:6 = 2.08$ times cheaper than coke furnaces, in countries where fuel is cheap. Making the same comparison in countries where fuel is dear (Mexico, Central and Southern America, Africa, etc.), and taking $12.50 to be the cost of one ton of coke delivered at the mines (this cost is much lower than the average in the countries mentioned; cases can be cited in Mexico in which the cost is over $30), the following conclusion is reached: $6 in electric energy is equal to $12.50 \times 2.50 = \$31.25$ in coke, which is equivalent to saying that the employment of electric furnace is $31.25:6 = 5.208$ times more economical than coke furnaces in the treatment of such ores as copper, lead, gold and silver ores.

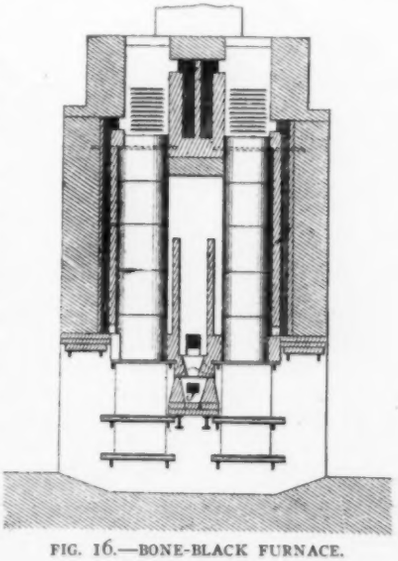


FIG. 16.—BONE-BLACK FURNACE.

To this great economy must be added the other numerous advantages obtained from the use of the electric furnace, and which may be summarized as follows:

1. Great facility in the regulation of the heat by the simple handling of the electrodes.

2. Constant production of the exact heat necessary, no matter its intensity.

3. Entire elimination of the chilling of the slags, so prejudicial in coke furnaces.

4. Easy treatment of all classes of ores, no matter how refractory.

5. Higher percentage in recovery of metals as a consequence of (a) the non-oxidizing action of the electric heat, which is produced without air or oxygen; (b) the production of lesser quantity of slags, and the greater fluidity of these.

6. Decrease in manual labor: (a) due to lesser quantity of materials to be handled; (b) because the ores can be treated as they come from the mines without the necessity of having them broken or bound when in dust.

7. Complete suppression of blowers and tuyeres.

8. Decrease in expenses of maintenance and repairs due to the maximum temperature being in the center of the ores treated, and not on the walls of the furnace, as in ordinary furnaces.

9. Production of a purer product, the electric heat being chemically neutral and not conveying to the metal the impurities always contained in the usual fuels.

10. Possibility to operate profitably mines situated far from means of communication, due to the facility of transmission of the electrical energy.

11. In all cases, decreases in transportation expenses, due to the facility of treating the ores even at the mines.

12. Yields as high from smaller plants as from larger ones.

So many important advantages, combined with the economy obtained, give to the electric furnace an indisputable superiority over the coke furnaces in all and every case, if the electric energy is as cheap as assumed, but, above all, in countries where coal and coke are dear and means of communication difficult and rare. Therefore, the employment of the electric furnace as a substitute for coke furnaces cannot be doubtful in the treatment of iron, copper, lead, gold and silver ores, in all countries where a natural source of energy, a waterfall, for instance, may be disposed of.

In this case, the treatment in electric furnaces will certainly be always much more economical even than the cyaniding process in treating gold and silver ores, and has, besides, the advantage of recovering a greater percentage of metals—95 per cent as a minimum against the 87 per cent gold and 80 per cent silver.

It is evident that the economies effected by the use of the electric furnace against the use of fuel as a thermic agent will be greater as the normal working temperature of the furnace increases, because the thermic efficiency of the ordinary furnaces decreases very rapidly as the temperature increases.

If we consider the treatment of iron ores, which demands a temperature of 1500 deg. C. as a minimum, the thermic efficiency obtained from direct-fired furnaces will be excessively low; in this instance, the recovery of a part of the heat carried away by the smoke is indispensable.

In spite of this recovery, it could easily be shown that one horse-power per year is equivalent to 2800 kilograms of coke consumed in an ordinary blast furnace.

Furnaces in which the Ore is not Fired Direct.—As has been demonstrated, electrical energy is much more economical than fuel as a thermic agent in metallurgical furnaces of direct firing. The evident result, therefore, is that the economies obtained will be still greater in furnaces where ore is indirectly fired which have a very low useful efficiency, while the electric furnace always gives the maximum efficiency, because the ores treated by it always are in direct contact with the source of heat.

Therefore, the following equivalences are obtained, which, with the ones given above, are corroborated by practice:

1. In the furnaces used for the *treatment of tin ores, one electric horse-power per year is equal to 3600 kilograms of coke,* and yields a greater quantity of tin, because this metal is neither oxidized nor carried away in the form of vapor by the smoke.

2. In the furnace employed in the *treatment of zinc ores, one electric horse-power per year is equal to 8000 kilograms of coal,* and the percentage obtained is not less than 95 per cent zinc, against the 85 per cent obtained by the ordinary processes.

3. In the manufacture of *crucible steel, one electric horse-power per year is equa. to 18 tons of coke,* this proportion being due to the high temperature required (1650 de. C.).

Finally, when it is necessary to obtain temperatures above 1700 deg. C., which is exceedingly difficult in ordinary furnaces, the employment of the electric furnace becomes absolutely indispensable. It is this which explains the present use of the electric furnace for making certain ferro-alloys.

As the generation of one electric horse-power per year produced in gas engines calls for a consumption in coal of not more than 3855 kilograms (440 gr. per horse-power per hour), it can be concluded that in the treatment of tin ores, and, above all, of zinc ores, as well as in the manufacture of steel alloys and crucible steels, the use of electric furnaces is more advantageous, even should the electrical energy be produced by thermic engines consuming fuel.

Examining the numerous advantages of the electric furnace described above, it may seem strange that its use has not been developed to a greater extent. To account for this, it must be borne in mind that electric science is still comparatively new; that the electric furnace has been but slowly perfected, and only in the most recent years; also that any innovation, no matter of what nature, modifying an established order of things, always encounters difficulties in application.

Actually, these difficulties as regards electrometallurgy have disappeared, or are about to disappear; the generation and transmission of electrical energy is now well understood, and electric furnaces have been greatly perfected.

Therefore, it seems that there is no question that the use of the electrical furnaces will be rapidly developed, and that in a number of years we shall witness these furnaces exclusively in use in all cases for the treatment of tin and zinc ores (without referring to the other metals employed in a lesser degree), and also in the smelting of iron, copper, lead, gold and silver ores, wherever an electric horse-power per year can be obtained at a cost less than three times the cost of a ton of coke.

Mexico City.

Physical Chemistry and Electrochemistry at the College of the City of New York.

By Leo Frank Guttmann, Ph.D., F. I. C.

The physical-chemical laboratories of the College of the City of New York are situated on the ground floor of the Chemistry Building and comprise the main laboratory, an electro-analysis room and an adjacent electric-furnace room.

The main laboratory faces northeast and contains three tables with working places for 12 students at each, and a narrower table provided with a glass top with six working places. Five hoods with glass sides and porcelain-tiled backs are ranged along the south wall, and one open sheet-iron draught hood is placed over the blowpipe table. A large thermostat of the Ostwald pattern is placed in the corner between the end hood and a window.

A row of five windows faces the hoods, and use is made of the extra wide window shelves to place balances thereon. Ana-

lytical balances weighing to 1/10 milligram are provided for calibration purposes, and one other of a more sensitive pattern, as well as a large one carrying up to 1 kg. with a sensibility of half a milligram.

Three sets of glass shelves with five tiers are provided for reagents, and a blackboard, book shelf and cabinet for apparatus complete the equipment.

The general arrangements are the same as those in the rest of the Chemistry Building. The laboratory is supplied at each hood with an H_2S outlet consisting of a hard-rubber valve connected to large Parsons generators in the basement, gas, water, steam, vacuum and compressed-air outlets. The main sink is

FIG. 1.—ELECTRO-ANALYSIS ROOM.

supplied with hot and cold water and one distilled-water outlet, while the small sinks attached to the laboratory tables are provided with two cold-water outlets only. The sinks are of porcelain and of the roll-rim flush pattern.

Artificial ventilation supplied by motor-driven fans is used for the laboratories, and a separate powerful exhausting system ventilates the fume hoods.

All main pipe lines are carried exposed suspended from the ceiling, so as to be readily accessible for repairs. Each line can be completely shut off by means of a floor valve, so that repairs needed in one laboratory do not incapacitate the remaining laboratories on the same floor.

The chief feature is the arrangement of the pipe lines (gas, vacuum, compressed air, water, direct and alternating current, and storage-battery current), which are carried along the center of each table in a raised enclosed trough of alberene. By this means all obstructions are avoided, and any accidental spilling of liquids cannot foul the current outlets which are raised 2 in. above the level of the table top. As in the other laboratories, all table tops and hood bases are of alberene.

Two low alberene tables placed on concrete piers are provided for two D'Arsonval galvanometers of the Nadler, and Leeds & Northrup pattern. One of these galvanometers is connected by means of a five-way plug switch to as many working tables, thus enabling several students to perform identical experiments (say, with thermocouples).

The large thermostat is kept at 25°, a smaller one being used for various temperatures. The laboratory is equipped with several motors, both hot-air and electric, for stirring purposes, with a larger one with universal movement (Koehler) and with a selected stock of physico-chemical apparatus. There are besides a set of mercury pipettes and burettes for gas analysis according to Ramsay and Travers, a Wilson electroscope, several ordinary tin-can electroscopes with telescopes for radioactivity determinations, a Ramsay-Tœpler vacuum pump, a standard Weston cell, a set of D. R. volumetric apparatus, and a good blowpipe for glass blowing.

Communicating through a side door is a small private laboratory for the instructor, containing besides the usual equipment, an electrolytic panel similar to those placed in the electro-analysis room. Students' reports on the work done are handed in on large cards, which can be folded and filed for reference.

The electro-analysis room is equipped with 14 working places, each place containing an electrolytic panel with three measuring instruments protected by a glass front, a rheostat, a knife switch and direct- and storage-battery current outlets. The arrangement is according to Prof. Edgar F. Smith, of the University of Pennsylvania.

The measuring instruments comprise one ammeter, 0 to 1 amp, graduated in 100 divisions; a second one 0 to 25 amp, with 1/5 amp graduations, and a voltmeter reading to 50 volts in half-volt divisions. The enamel type rheostat has a total resistance of 172 ohms.

The electro-analysis room likewise contains the big distributing board for storage-battery current, which controls every outlet in the building. It consists of a vertical marble slab provided with copper-lined equidistant holes. Each pair of holes is numbered and leads to the correspondingly numbered outlet in any laboratory. Current is furnished by connecting the two outlets by means of flexible cables with the power board.

The power board contains five busbars, each provided with 24 distributing sockets, and connected to four batteries in the accumulator room. The batteries are connected in series with the busbars, giving an e.m.f. of 4 volts between the first two busbars, 6 volts between the second and third, and third and fourth, and 8 volts between the fourth and fifth, a total of 24 volts between the two end busbars. By this means any desired voltage from 4 to 24 volts (with the exception of 18 and 22) in 2-volt steps can be obtained.

The accumulator room is in the basement and contains 48 chloride cells. These have a discharge rate of 60 amp in one hour and 120 amp-hours capacity on an eight-hour discharge.

The cells are permanently connected as follows: One bat-

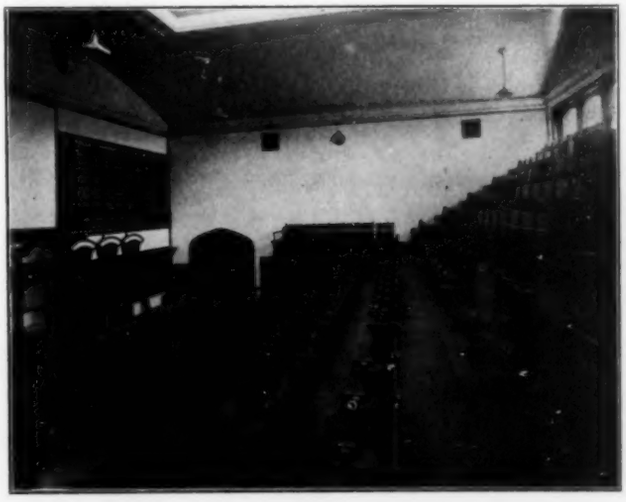


FIG. 2.—LECTURE THEATRE (SHOWING ELECTRIC INSTRUMENTS).

tery of eight cells connected two in series and four in parallel, giving 4 volts and capable of discharging at the rate of 60 amp for eight hours; two batteries of six cells each, connected three in series and two in parallel, giving 6 volts with a discharge rate of 30 amp for eight hours; and one battery of eight cells connected four in series and two in parallel, giving 8 volts and of the same discharging capacity as the 6-volt batteries. The remaining 20 cells are connected in series.

The 6-volt and 8-volt batteries can be discharged so as to

give 120 amp in one hour, and the 4-volt battery can give 240 amp in one hour. By means of a double-pole, double-throw knife switch of 50-amp capacity each of the 6-volt and 8-volt batteries can be connected in series for charging purposes. A similar arrangement with three knife switches enables the 4-volt battery (four in parallel) to be connected in series, giving 16 volts. The motor-generator can then be used to the best advantage, and each cell be charged at the proper rate of 15 amp.

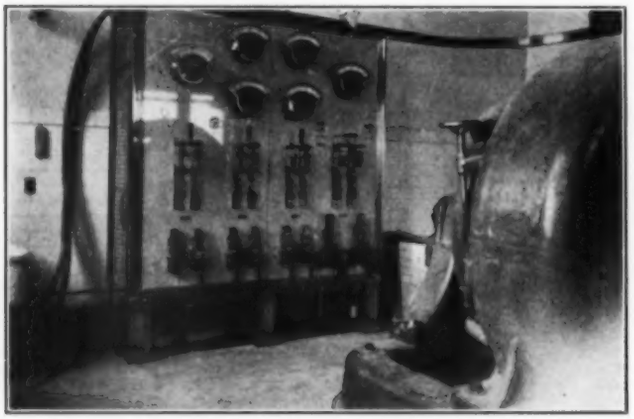


FIG. 3.—ELECTRIC-FURNACE ROOM.

One hundred-ampere fuses are placed between the busbars and the leads to the respective batteries in the accumulator room.

The charging outfit comprises a motor-generator giving 20 amp up to 125 volts, a switchboard provided with an ammeter reading to 25 amp, and a 125-volt voltmeter, both instruments with illuminated scales, various knife switches, starting and controlling rheostats and cut-outs. The charging leads are led directly to two sockets on the distributing board in the electro-analysis room, and connection is made there with the cells to be charged. Two portable cables in the accumulator room likewise lead to two outlets on the distributing board so that any number of cells can be permanently assigned for a specific purpose, or the condition of any cell investigated in detail. By these means the accumulator room need never be entered except for inspection.

Current is supplied to the user at the voltage and current asked for, a suitable fuse being inserted in the cables making

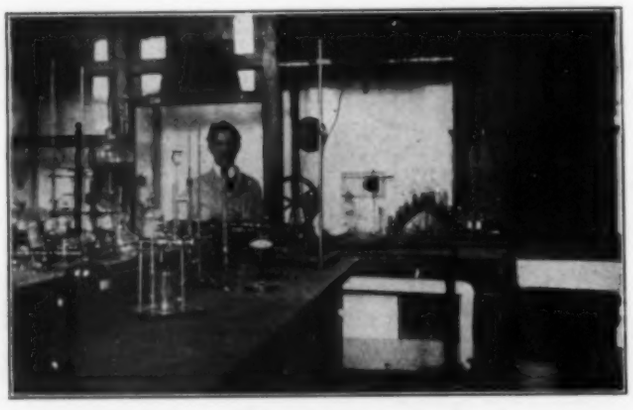


FIG. 4.—PHYSICO-CHEMICAL LABORATORY.

the connection on the distributing board. On disconnecting any allotted cells, the user is asked to state the approximate number of amperes taken from them. A record of this is kept for each battery, and it is then easy to tell how much charging is required. The cells in each battery being used up at the same rate are always in a comparable state, and any individual cell is thus always protected from being run down by a careless user.

A portable voltmeter, reading directly to 0.1 volt, is provided for testing the cells. All current cables can carry up to 50 amp, but, as a rule, 5 or 10 lamp fuses are inserted in the connecting cables on the distributing board. Arrangements are now being made to simultaneously supply 56 freshman desks with current at 4 volts from the 4-volt battery.

A room for spectroscopy, finished in black and equipped with students' instruments as well as with two accurate spectrometers, adjoins the electric-furnace room. The latter is equipped with generators and transformers capable of giving up to 3000 amp at 15 volts, the current being distributed through cables pivoted on a central iron beam. Open draught hoods are ranged along the side of the room and the electric furnaces, which are built as required, will be placed under them.

A word should be said as to the projection-lantern equipment of the lecture theater and lecture room. While the projection lantern is being prepared for demonstration, the lecture rooms can be darkened by means of black window shades actuated by electric motors, thus affording a considerable saving in time.

The above description is published with the sanction of the Director of the Department of Chemistry.

The College of the City of New York.

Notes on Electrochemistry and Metallurgy in Great Britain.

(From Our Special Correspondent.)

The Faraday Society.

On February 9 Dr. S. Rideal read a paper on the "Application of Electrolytic Chlorine to Sewage Purification and Deodorization by Oxychloride" (see p. 168). The discussion was opened by Mr. H. C. H. Shenton, who said that, speaking as an engineer and not as a chemist, he had, in association with Mr. W. Pollard Digby, several years ago advocated the sterilization of sewage effluents and some of the criticisms then advanced he would now meet. The difficulty arising from storm water had been much overrated; for storm rushes were not continuous, but only of short duration. Some sanitary authorities were opposed to sterilization; but as a rule they could give no valid reason, and their dislike of sterilization arose from their complete ignorance of the subject. The practicability of the process had been demonstrated, and it was decided on at Baltimore, U. S., and at Hamburg. He considered that manufacturers of hypochlorite plants were themselves largely to blame for the prevailing ignorance; but official apathy was also responsible; and the extent to which pollution of the river Thames and of the Lee is permitted, was most reprehensible. The Local Government Board had long ago sanctioned a scheme of his for the river Lee, but nothing had been done. At last, however, the practicability of sterilization was beginning to be recognized.

Mr. Edward John Silcock, in his inaugural address, as president of the Society of Engineers, on February 1, had said: "As to whether or not any of our present systems of purification are sufficiently effectual to purify the sewage of a town and discharge it into a river, the water of which is subsequently used for domestic consumption, is open to doubt. Recent investigations indicate that the effluent from even the best land treatment contains bacteria, some of which may be pathogenic; and that the effluent from a bacterial system of purification contains at least an equal number of bacteria. Under these circumstances it is probable that the future trend of scientific opinion will be in the direction of requiring the effluent from works so situated to be sterilized before being discharged into the river."

Mr. A. J. Martin differed from the last speaker as to the storm water question, and considered it a much more formidable difficulty than Mr. Shenton did. A storm rush might amount to from 20 to 50 times the ordinary flow, to deal with which necessitated an enormous plant capable of being brought into action

instantly. An important feature in favor of chlorine was its prevention of the clogging of the pipe-heads.

Mr. W. Pollard Digby, while fully recognizing the value of the bacteriological side of the paper, regretted that on the electrochemical side data should not have been furnished which would be of any relative value in the records of hypochlorite production. There was no desire to ask for details of construction which might be regarded as works' secrets; but nothing was said as to the utilization of the diaphragms. He had experimented with cathode and anode diaphragms several years ago; and more recently had found considerable advantage in the use of double diaphragms keeping the main body of the electrolyte from contact with either of the electrodes. The society was entitled to ask for details both of application and manufacture. Neither the strength of the solution at which the stated efficiency was obtained nor the salt consumption in relation to available chlorine were given; and in view of the advantages claimed it was legitimate to ask for tangible proof. He could claim to be, with Dr. Rideal, one of the pioneers of sewage sterilization, but Dr. Rideal was the missionary pioneer, and his work at Maidenhead and Guildford had been of much value and interest.

These results were followed, in the United States, by the work of Phelps, Carpenter, Kellerman, and others, and showed that sterilization of sewage was practicable cheaply. Catchment areas are limited, and when one realized the cost of a Welsh water scheme for London, it was obvious that great capital outlay can be saved if the water authorities insisted on the sterilization of sewage effluents entering the Thames, although that would not obviate the necessity for care and precaution at the waterworks. It would be well to restrict fancy names to the apparatus, and to call the chlorine solutions by their proper chemical names.

In the paper a distinction was made between the old "oxychloride" and the new "oxychloride," which merely serves to show that the same material may be well made or badly made—reserving the latter adverb for unstable solutions which part with their chlorine at too rapid a rate. All who made hypochlorite solutions with the view of obtaining a stable product are in the habit of watching temperatures and employing means which they do not talk much about—except Dr. Alexander, whose policy is that of frankness itself; and he wished the Oxychloride Company were half as frank in regard to efficiencies and methods of working. He did not see any hope for a carboy trade to small sewage works. Nearly every sewage works has motive power available; and, even taking a 15-gram solution, transport would entail payment for a very large quantity of water plus a certain amount of useless salt per unit of available chlorine. Chemical manufacturers supplying "chloride of lime" would be in a better position because that substance is compact and gives a greater quantity of chlorine per unit of waste.

Mr. A. B. Thomson said there was a difficulty in giving definite figures as to the cost of the process; it would be regulated to a great extent by the expenditure for power and materials which varied in different localities. He was not able to agree with Mr. Digby's statement that the distribution of hypochlorite in carboys was hopeless, since electrolytic chlorine was superior to chloride of lime for sterilizing purposes and was free from defects appertaining to it such as clogging of filters by the suspended lime.

Mr. I. Fieldhouse remarked that the supply of the requisite quantity of hypochlorite for a storm-rush was secured by an automatic valve regulating its flow from special storage tanks.

Mr. J. H. Johnson pointed out that the purification of sewage has been demonstrated by recent research to be essentially physico-chemical, and not bacterial, by reason of sewage containing much matter in colloidal solution.

Mr. F. E. Pollard objected to the repeated use of the word oxychloride in the paper in such a manner as would lead those unacquainted with the fact that oxychlorides are not capable of giving rise to the liberation of nascent oxygen to suppose that the active substance is really an oxychloride. The names of chemical products should be such as would accurately set forth their constitution.

Dr. Rideal replied briefly, and remarked that the constitution of the electrolytic liquid was surrounded by considerable uncertainty. The general supposition was that the electrolysis of the salt solution resulted in the production of hypochlorite; but recently he had ascertained the presence of chlorite. He had not found that any chlorate was formed when working with a cold solution, whether diaphragms were employed or not.

The Aluminium Corporation.

The adjourned statutory meeting was held on February 17. Mr. A. H. Gibson, chairman, after reciting the various liquidation schemes which had been put forward, said, on February 3 the liquidators received a letter from the British Aluminium Company offering to purchase the undertaking on the following terms: £50,000 in cash for the assets; 10,300 fully-paid 6 per cent £5 shares; and 90,000 6 per cent preference shares of £5 each, of which £2 10s. 0d. had been paid, leaving a liability in the last-named shares of £24,500. So that the terms were briefly —£50,000 in cash; £50,030 fully-paid preference shares, and £24,000 partly-paid shares. Mr. Graham had some correspondence with Mr. Touche on the matter, and the latter gentleman replied in answer to a question that if it was preferred, the partly-paid shares would be eliminated from the terms. There were also further conditions named by the Britism Aluminium Company as to the contracts made by the Aluminium Corporation. However, after looking at the matter from all points of view, the liquidators had come to the conclusion that it would be better to reconstruct the concern than to sell it.

Mr. Scott, chairman of the creditors' committee, said that he regarded the reconstruction scheme as being more favorable for them than being taken over by the British Aluminium Company. Obviously the scheme was the better one, as the creditors besides getting cash got shares in well-secured stock. The creditors felt that the shareholders through their liquidators had had a fair term of putting the business right, and they considered that they should now appoint a sole liquidator. He accordingly moved a resolution to the effect that Mr. Robertson Lawson be appointed sole liquidator of the company, and that Mr. Scott in conjunction with the other members of the creditors' committee, be authorized to make such application before the court.

Mr. Robb moved a resolution providing that in the event of the liquidator not being appointed on or before February 27, the date when the winding-up petition will be heard, his clients (Messrs. Brownlie & Murray) should make an application for a liquidator to be appointed.

After discussion this was defeated, and Mr. Scott's resolution was carried.

Russian Platinum Monopoly.

Most of the platinum producers in the Ural have for years past been bound (according to the St. Petersburg correspondent of the Berlin *Tageblatt*) by a contract to deliver the whole of their output to an English firm; but as the latter paid a lower price than the French firm of Bonardelle, with whom the remaining Ural producers were working, the majority have now resolved to pay the indemnity provided for in the contract, and to dissolve the business connection with the English firm. All the producers in the Ural are forming jointly with the French firm in question a company for the working of the Tagilsk mines, the French firm taking over shares to the extent of 6,000,000 roubles (£600,000). The minimum price for platinum has been fixed at 28,000 roubles per pood, or considerably higher than at present. It is added that the question of establishing a monopoly in platinum has again been raised, and a conference is about to be held at St. Petersburg under the

presidency of an official of the Ministry of Commerce for the purpose of regulating the trade in the metal.

From an article in the *Chemical Trade Journal* it appears that, in 1907, when the price of platinum was low, a foreign syndicate commenced to buy up the smaller platinum concerns in Russia, and entered into an advantageous contract with the largest: the Tugil and Schouvaloff houses. This syndicate (not named) has since gradually acquired control of the whole Russian market, and the smaller producers find themselves obliged to sell their concerns to it at practically any price. This has resulted in an agreement among the producers, who are now endeavoring to get the government to regulate the industry. This the foreigners are trying to combat by allowing the price of platinum to rise.

High-Speed Tool Steel.

A recent announcement of Professor Arnold, of Sheffield University, that, within a year, a British steel of quadruple the cutting power of any steel now known would be on the market raised great expectations; but inquiry of the well-known firm whose name was given in connection with the matter—Messrs. Jonas & Colver—has failed to elicit confirmation of Professor Arnold's statement, and the Sheffield steel manufacturers have protested strongly against the same, for they say it has led to the countermanding of orders for old qualities of high-speed steel and has caused serious loss in the trade.

Market Prices.

The market prices during February, 1909, were as follows:

Tin: After a drop at the beginning of the month to £123.15s., tin has risen in jerks, principally between the 4th and 11th, to £130.15s. on February 23. Since then the fluctuations have been less heavy; price on the 26th, £129 to £130.

Copper has had a downward tendency, recovering slightly from £57.10s. on the 1st to rise to £59.2.6 on the 10th, and dropping again to £56 to £57 at the end of the month.

English Lead has been inclined to rise from £13.10.0 on the 1st to its final price, £13.15.0, commencing to improve about the 8th. No fluctuations.

Hematite dropped on the 3d from £2.17.4 and continued downward to £2.16.4 on the 10th; generally flat to £2.16.0 on the 26th.

Cleveland Warrants have been in a depressed condition, varying from £2.8.0 to their present price, £2.7.0.

Scotch Pig has shown a downward tendency; opening above £2.8.0, it has dropped steadily during the month to the neighborhood of £2.6.10.

Chemicals:

Sulphate of Ammonia, f. o. b. Liverpool	£11.	7.	6
Copper Sulphate	21.	0.	0
Caustic Soda, white, 77 per cent	11.	2.	0
Bleaching Powder, 35 per cent	4.	5.	0
Antimony, Black Sulphate Powder	25.	0.	0
Shellac, Standard, T.n. Orange Spots, per cwt	4.	0.	0
Carbolic Acid Liquid, 97 to 99 per cent, per gal			11
Creosote, ordinary good liquid, per gal			2¾
Naphtha, solvent, 90 per cent at 160° C., per gal			9
Rubber, Para fine, per lb		5.	3¼
Pitch, f. a. s. Manchester, per ton		18.	0

Shipment of Calcium Carbide.

In view of the recent discussion of alleged danger in the transport of ferro-silicon the following notes on the shipment of various chemicals and especially of calcium carbide should be of interest. They are taken from a very useful little book issued by Messrs. Oelrichs & Co., of New York City, entitled "Aids to Shippers."

A United States statute prohibits the shipment, among other things, of nitroglycerine, naphtha, benzine, benzole, coal-oil, crude or refined petroleum, or other like explosive-burning fluids, or dangerous articles carried as freight or as stores on any steamer carrying passengers. Under the provisions of the statute every person knowingly transporting or delivering any of the articles above referred to on a steamer carrying passengers renders himself liable to a fine. It is, therefore, incumbent upon shippers always to obtain a "special permit" from the transportation company before making delivery of cargo of hazardous or inflammable nature.

By virtue of a circular issued by the Secretary of Commerce and Labor calcium carbide may be transported on vessels carrying passengers when the carbide is contained in steel drums or steel receptacles, the seams of which are lapped and properly riveted or fastened in such a manner as will best insure the maximum strength of the joints, and when the said drums or receptacles are fitted with double covers, so that such drums or receptacles shall be water-tight as well as air-tight during the transportation. For packages weighing 110 lb. or less the drums or receptacles shall be made of open-hearth steel of not less than No. 26 gauge. Packages weighing more than 110 lb. must be placed in drums or receptacles constructed of open-hearth steel of not less than No. 24 gauge. In addition calcium carbide or carbide of calcium may also be transported in cans containing not more than 10 lb. each on vessels carrying passengers.

ANALYSIS OF CURRENT ELECTROCHEMICAL PATENTS.

Electric Melting Furnace.—To add ferromanganese to steel, W. Schemmann and J. Brown, of Rombach, Germany, recommend to add the ferromanganese in liquid form, for reasons explained at some length on another page of this issue under Recent Metallurgical Patents. They have devised a special melting furnace, four sections of which are shown in Fig. 1. It is intended for use on a three-phase system and has, therefore, three electrodes, 6, 7, 8. The modern ferromanganese is contained in the three gutters, 2, 3, 4, which lead into a common crossgutter 5. The molten ferromanganese is tapped through the tapping hole 9 simply by tilting the furnace. But

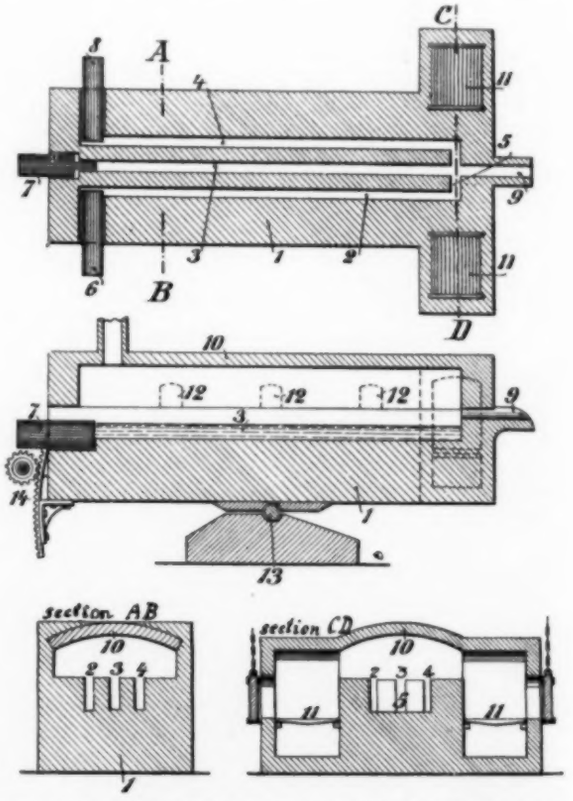


FIG. 1.—ELECTRIC FURNACE FOR MELTING FERROMANGANESE.

the capacity of the melting furnace is made 5 to 10 times the amount taken out at each tapping. Whenever some molten metal is taken out, new solid ferromanganese is added and the furnace remains in continuous operation. (915,488, March 16.)

Carborundum.—According to the well-known method of manufacture of silicon carbide, a mixture of pulverized coke, sand, salt and sawdust is subjected to great heat in an electric furnace. The resulting product is a loose aggregation of crystals of various sizes with a considerable proportion of interstices in the crystal mass. Mr. Frank J. Tone, superintendent of the Corborundum Company, has discovered that if porous masses of silicon carbide be embedded in a body of silica and carbon, and the latter be heated to the temperature of formation of silicon carbide, preferably by passing the electric current through a central conducting core of carbon, the vapors of silicon and carbon or their compounds will build upon and in the mass of silicon carbide crystals, and will convert it into a dense compacted and non-porous state. While not being able to state positively the nature of the reaction, Mr. Tone attributes it to the reversibility of the reaction

$$2\,SiC + SiO_2 = 3\,Si + 2\,CO.$$

He believes that silicon has the property of reducing CO at certain temperatures just below the decomposition temperatures of silicon carbide and that the silicon carbide thus formed is deposited in the pores of the crystalline mass, making a dense compacted form. (913,324, Feb. 23, 1909.)

Precipitation of Copper.—A patent of Mr. Arthur Ramen of the Helsingbors Kopparverks, at Helsingborg, Sweden, refers to the precipitation of copper from the solution obtained from the ores after chlorinating roasting. Part of the solution is treated with metallic iron to precipitate cement copper. The other part is electrolyzed in the cathode chamber of a diaphragm cell, while the anode chamber is filled with the ferrous-salt solution, resulting from the precipitation of copper by means of iron. The object is, of course, to reduce as much as possible the voltage required at the terminals of the electrolytic cell. (913,430, Feb. 23, 1909.)

Gas Cell.—If an electrode of porous carbon, the pores of which are filled with oxygen, is placed with an iron electrode into a suitable electrolyte, such as the solution of an ammonium salt, and the circuit is closed between the carbon and the iron, current will pass in the cell in the direction from iron to carbon. The iron is dissolved, producing double salts of iron and ammonium, out of which hydrates of iron are by and by precipitated by the ammonia generated at the cathodes. But when all the oxygen in the pores of the carbon has been consumed, and when the pores are then filled with electrolyte, the action stops. In order to get a continuous generation of electrical energy from the oxidation of the iron, it is necessary to keep the pores of the carbon open and filled with oxygen. Mr. E. W. Jungner, of Kneippbaden, Norrkoping, Sweden, who is well known by his early work in competition with Mr. Edison in the development of an iron-nickel accumulator, proposes the cell, shown in Fig. 2 for this purpose. The bottom of the vessel B contains an electrode A of iron, and above it, up to the level N, is the solution of the ammonium salt. A second porous clay vessel P within the first contains a solid carbon conductor D and around it small pieces of porous graphite G, saturated with the electrolyte. These pieces are of such a shape and size that the internal spaces between them are not filled with electrolyte by capillary action. The open holes are kept filled with oxygen by a current of air passed through tube R to the bottom of the porous vessel, then rising upward and leaving through tube R_1. Another gas cell described in the same specification is based upon the combination of oxygen and hydrogen gas to form water. (913,300, Feb. 23, 1909.)

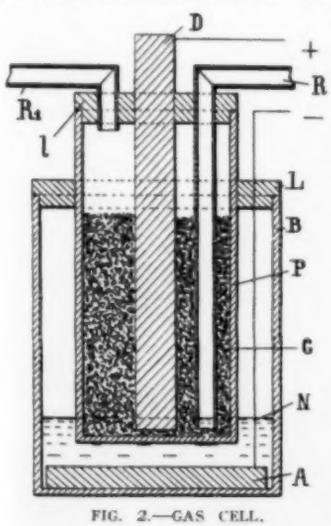


FIG. 2.—GAS CELL.

Metallic Mirrors for Searchlights.—The manufacture of metallic mirrors involves considerable difficulties, since it is not easy to obtain cast or spun metal free from flaws and with a surface which, when highly polished, does not show the grain of the metal. Moreover, for spinning, comparatively thin metal has to be used which is not sufficiently rigid for a mirror of large dimensions. Mr. Sherard Cowper-Coles, of London, who has given much attention to this subject, as to other matters in metal deposition, casts the mirror of suitable metal such as iron, brass, gun-metal or German silver, or he spins or stamps sheet metal to the desired curvature. The body is then placed in an electrolytic cell wherein a metal such as copper is deposited on the back thereof, until it has obtained the desired thickness to make it rigid. He then places the mirror in another electrolytic cell, where silver, nickel or cobalt or a suitable silver alloy is deposited upon its reflecting surface. The surface of the mirror is then ground and polished. The above operations may be repeated any number of times until a surface is obtained which corresponds to that of glass. Finally, annular or radial bands of gold or other yellow metal may be deposited in order to obtain white and yellow beams which can be well seen both by day and night and also in foggy weather. (915,415, March 16, 1909.)

SYNOPSIS OF PERIODICAL LITERATURE.

Theoretical and Experimental.

Standardization of a Potassium Permanganate Solution.—Cornelis Offerhaus and Ernst H. Fischer (*School of Mines Quarterly*, Vol. XXX, No. 1) call attention to sodium oxalate "Sörensen" as a standard for the potassium permanganate solution; this salt is in Europe already in general use for this purpose and recognized as the only reliable standard for oxidimitry. They compare sodium oxalate "Sörensen" with electrolytic iron, "Burgess," as to their suitability to serve as standards for the permanganate solution and recommend sodium oxalate "Sörensen" as a result of their investigation, pointing out its advantages. They find that also in using Zimmermann-Rheinhardt's method to standardize the $KMnO_4$ solution, sodium oxalate may be used to advantage.

Pyrometer.—A simple form of thermoelectric pyrometer for students' use was exhibited recently by C. R. Darling before the British Physical Society and is described as follows in the (London) *Electrician* of March 12: In this instrument the hot junction of nickel and steel, or iron and constantan, is protected by a mild-steel cap, bored from the solid, and about 6 in. in length. This cap is screwed to an iron barrel of any desired length, and the wires pass from the junction through twin-bore fireclay to terminals screwed into a piece of hard fiber. The terminals are made of the same metal as that of the wire attached, and leads of the same wire are taken to a cold junction, kept in oil, and the indicator. The pyrometer is easily put together by the students and is used to form a temperature-scale from the deflections of a galvanometer by insertion in molten metals, or salts of known freezing points. The mild-steel cap resists the action of molten substances far better than porcelain or silica, and enables the junction to follow a changing temperature more rapidly. The errors incidental to the forms in which no provision is made for temperature changes of the cold junction are avoided, and no damage ensues from dropping or rough usage as in the case of pyrometers protected by porcelain or silica. The cap, when worn out,

is readily replaced. At the same time Mr. Darling described the following combined meter-bridge and potentiometer, with a new tapping-key device for pyrometric and general laboratory work. The arrangement of this apparatus is that of an ordinary meter-bridge with four gaps, but with four meters of stretched wire, so that one, two, three or four meters of wire may be used in a bridge. Between each pair of wires is placed a groove, through which passes a rod of phosphor-bronze on which the tapping key slides. These rods are connected to a terminal at the side. Hence, it is not necessary to connect directly to the keys. The keys are furinished with two knife edges, and may be depressed onto the wires on either side of the groove in which they slide, thus facilitating the finding of the balance-point. Each wire is furnished with an arrangement for tightening. The apparatus may be used as an ordinary bridge or as a bridge with calibrated wire, it being possible to calibrate any wire by the aid of others. It may also be used for the measurement of the e.m.f. of thermal junctions, constants of cells, etc., and all the ordinary purposes of a stretched-wire potentiometer.

Rheostat for Small Electric Furnaces.—A simple rheostat was exhibited by C. R. Darling before the Physical Society of London and is described in the (London) *Electrician* of March 12. The defect of the ordinary carbon-plate rheostat (difficulty of accurate control when consuming a large amount of energy) is overcome in this instrument by the use of four rows of plates, each 2 in. square, there being 22 plates in each row. Each set of plates is furnished with a separate adjusting-screw and hence may be kept at different degrees of tightness. By means of simple connecting devices, the plates may be used in series or parallel as desired. This form of rheostat is found to be well adapted for regulating electric tube furnaces and for varying the current to any desired extent during the calibration of instruments, etc.

Industrial Electrochemistry.

Hypochlorite for Sewage Purification.—A recent Faraday Society paper of Dr. S. Rideal dealt with the "application of electrolytic chlorine to sewage purification and deodorization by the 'oxychloride' process." The paper contains an account of an elaborate investigation carried out by the author at Guildford on the use of hypochlorite solutions in sewage treatment. The experiments were made on a fairly large scale on the town sewage at the Corporation Works. This when it emerges from the septic tank is dark colored, more or less fetid from the presence of sulphuretted hydrogen, and contains very large numbers of bacteria, some of which are capable of producing disease. By adding a small quantity of a chlorinous liquid the odor is removed, and any nuisance arising from sewage distribution is completely avoided. But the most important feature is that the effluent is rendered harmless, the disease-producing organisms being destroyed. After the publication of the author's first experiments in 1904, the Royal Commission on Sewage Disposal visited Guildford and confirmed the results, further finding that the chlorine treatment did not hinder the subsequent purification in the bacterial coke filters. During 1907 and 1908 Dr. Rideal has continued the trials, and finds that the process actually *aids* the purification, first, by causing the filter-beds to mature more rapidly; secondly, by keeping the pipes free from fungus growths; thirdly, by the fact that the avoidance of clogging enables a finer filtering medium to be used, which gives better final effluents. The form of chlorine used was a hypochlorite solution prepared electrolytically. This method of sewage treatment has a great sphere of usefulness in preventing the pollution of rivers and in entirely removing aerial nuisance.

Iron and Steel.

Manganese, Iron and Carbon.—P. Wüst, in *Metallurgie* for Jan. 8, gives a summary of present information upon the influence of manganese on the iron-carbon combinations, from the earliest writings in the eighteenth century up to the present. The 47 references given, form a good bibliography of the subject. From this review, Dr. Wüst concludes that our information is still fragmentary and proposed for himself the following questions for investigation:

1. How is the solubility of carbon in melted iron affected by increasing manganese content?

2. What influence does manganese have upon the melting point, and other halt-points, of iron-carbon alloys with high percentages of carbon?

3. What alteration does manganese produce in the structure of high-carbon iron-carbon alloys? Is, in particular, the eutectic point of 4.2 per cent carbon displaced by the presence of manganese? If so, how much? At what manganese content does the perlite point disappear, and what constituent takes its place?

In the experiments, Swedish pig iron and "Goldschmidt" manganese were used with pure sugar carbon. Platinum wire heating furnaces were found unsuited for the experiments because even just above the melting point of the alloys manganese volatilized out of them and alloys the heating wire. This difficulty was overcome by surrounding the alloy by a wrought-iron tube, which intercepted the manganese vapors and thus protected the platinum.

Forty-two alloys were made with carbon 4.3 to 6.9 per cent and manganese 0.06 to 80.45 per cent. The conclusions of the investigation are as follows:

1. Manganese increases the solubility of carbon in such manner that with 50 per cent manganese, if the alloy is rapidly cooled, the compound $(Fe,Mn)^3C$ apears to exist in the alloy.

2. The addition of manganese up to 13 per cent lowers the melting point about 12° C. in spite of carbon having risen over 1 per cent; with 13 per cent more manganese, and carbon also 0.5 per cent higher, the melting point is back at the starting point. With 80 per cent manganese and 2.5 per cent more carbon, the melting point is 125° C. above the starting point.

3. Small quantities of manganese diminish rapidly the perlite point, 2 per cent reducing it 30° C. When over 5 per cent of manganese is present, the perlite point disappears completely.

4. Hysteresis of the perlite point is increased by manganese.

5. Increasing manganese hinders the formation of perlite and facilitates that of troostite and solid solution. When perlite disappears, its place is taken by solid solution of carbide in iron.

6. The eutectic point is displaced, and with 15 per cent of manganese lies at 4.05 per cent carbon instead of at 4.2 per cent, as in manganese-free pig iron.

Ferrosilicon.—In *La Lumière Elec.* of March 6, J. Escard begins an article on the processes used for making ferrosilicon. He first discusses the properties and production of the five definite compounds of iron and silicon; namely, $SiFe_2$, $SiFe_3$, SiFe, Si_2Fe and Si_3Fe.

Aluminium.

Use of Silicates in Its Manufacture.—The expiration of the aluminium process patents and the great increase in output of this metal have given rise to many scientific researches and commercial inquiries. In *Metallurgie* for Jan. 8, Max Moldenhauer discusses the availability of aluminium silicates as raw material for the industry. The inquiry is *apropos;* bauxite is found only in a few places, must be transported long distances, it usually contains some silica, so much that it must be separated out by a costly chemical operation. Aluminium silicates are found almost everywhere, and the separation of the silica from them may quite conceivably not cost more than counterbalances the scarcity and inaccessibility of bauxite.

From several electric-furnace experiments it is concluded that the question has been practically solved. By mixing aluminium silicate with iron ore and reduction carbon, the electric furnace product is a ferrosilicon and an alumina slag containing only very little silica and iron oxide. The slag is to be pulverized, the globules of ferrosilicon removed by magnetic separators, and the alumina used in the electrolytic pots.

Incidentally Herr Moldenhauer determined the melting point of cryolite and the lowering effected by dissolving alumina in it. His results are:

Cryolite					975° C.
"	plus	5	per cent	Al^2O^3	955
"	"	10	"	"	930
"	"	15	"	"	910
"	"	20	"	"	880
"	"	25	"	"	898
"	"	30	"	"	898
"	"	40	"	"	898
"	"	50	"	"	898

These figures are decidedly below previous results, and need confirmation. They were made with native cryolite and commercial alumina and not with pure materials. These mixtures are, moreover, veritable traps for the unsuspecting experimenter on account of the sur-fusion going down away below their proper freezing points before they begin to set, and then not retreating to the proper settling temperature if the cooling is proceeding too rapidly.

Alloys.

Platinum-Antimony.—K. Friedrich and A. Leroux give in *Metallurgie* of Jan. 8 a careful piece of work. They found, from the melting point curve, a distinct alloy, $PtSb^2$, with 47.5 per cent of platinum melting at a maximum of 1045° C. With increasing platinum, the melting point falls until the eutectic is reached at 75 per cent platinum, melting at the surprisingly low point of 683° C. Above this the melting point rose smoothly to that of platinum, 1775° C. Pt^3Sb^2 possibly forms in the solid alloy, being recognized miscroscopically, but does not show on the melting-point curve.

RECENT METALLURGICAL PATENTS.

Iron and Steel.

Adding Manganese.—Ferromanganese is the most important of all ferroalloys. The addition of ferromanganese to steel is usually effected by throwing large pieces of ferromanganese into the liquid metal immediately before pouring or tapping. But this method has decided drawbacks: a considerable portion of the ferromanganese is retained by the tough layer of slag on the molten metal; further, the temperature of the steel bath is reduced by the solid pieces of ferromanganese; and the manganese is not uniformly distributed throughout the steel bath. According to Mr. Wilhelm Schemmann and Mr. Jegor Brown, of Rombach, Germany, all these disadvantages are avoided if the ferromanganese is melted separately and added in liquid state to the liquid iron. They have devised a special small electric furnace for this purpose, which is described and illustrated elsewhere in this issue in the Analysis of Current Electrochemical Patents (though it would seem that a simple small induction furnace would also do very well just for this purpose). The advantages are that a very uniform distribution of manganese is obtained. Further, a much smaller amount of manganese is required than otherwise. For instance, cross-sections which when the steel was produced by adding ferromanganese in solid form required at least 0.4 per cent maganese, can be easily rolled even if the steel contains only 0.29 per cent manganese, provided the ferromanganese has been added in liquid form. There is, therefore, a double saving, because no manganese is lost in the slag and because the proportion of manganese in the steel can be reduced without impairing its quality. If, for instance, a converter charge of 15 tons of metal is to be finished by the addition of ferromanganese in solid form (taking into consideration that 25 per cent of the manganese added, that is to say, one-third of the manganese remaining in iron, becomes converted into slag) it is necessary for the purpose to use $15{,}000 \times \frac{0.4}{100} \times \frac{4}{3} = 80$ kg of manganese or 100 kg of ferromanganese containing 80 per cent of manganese. If ferromanganese is added in liquid form then for manufacturing a steel of at least the same quality and equally suitable for rolling, it is sufficient to have $15{,}000 \times \frac{0.3}{100} = 45$ kg of manganese or 50 kg of 80 per cent ferromanganese. If the total consumption of ferromanganese in a steel foundry is considered, the saving effected on a large number of charges will be still greater for the following reasons: Ferromanganese of high percentage cannot be stored, as the richer it is in manganese the quicker it is decomposed by the action of the moisture of the air into powder. As the latter is kept back by the slag cover when being thrown into the metal bath, it could not up to now be used at all and formed an inconvenient and expensive waste. If the ferromanganese is first liquefied even the powdered ferromanganese can be melted, so that also in this respect the process according to this invention is advantageous in view of the necessity of having large stores of ferromanganese which cannot be avoided where manufacture is carried on on a large scale. (915,488, March 16, 1909.)

Tin.

Detinning Tin Scrap.—A patent with considerably broad claims for a method of detinning with chlorine has been issued to Messrs. F. von Kügelgen and G. O. Seward. It is assigned to the Tin Products Co. Dry chlorine at a suitably low temperature combines with tin forming stannic chloride, but does not attack iron. Since the reaction evolves heat, care must be taken to keep the temperature sufficiently low, either by cooling the vessel or by limiting the amount of chlorine. At higher temperatures the iron is attacked. But the temperature must be high enough to secure a complete detinning. The first claim refers to "the recovery of tin from tin scrap by treating the latter in a closed vessel with dry chlorine to form stannic chloride, maintaining the temperature sufficiently high to effect complete detinning and controlling the temperature to keep it below that at which iron is attacked." (915,029, March 9. 1909).

Wet Process for Metal Extraction.

Gold, Platinum, Silver, Nickel, Copper.—Mr. A. Seigle, of Lyons, France, patents a wet process for metal extraction which we will describe as applied to the extraction of copper and nickel. The finely ground ore is mixed with quartz sand and placed in a digester fitted with mixing paddles and moistened with a weak solution of calcium and magnesium chlorides (a by-product of the ammonia-soda process) and a small quantity of protochloride of iron is added. The solution must be sufficiently rich in chlorides. When the ore and solution form a well-mixed fluid paste, steam is introduced into the digester at a pressure of 2 kg (42 lb. per square inch) or more, and the pressure is maintained for several hours or a day. The result of the reactions which go on is the formation of compound insoluble silicates of calcium, magnesium, iron, etc., and the formation of soluble chlorides of copper and nickel. (In this way it is possible to get chlorides of copper and nickel free from iron, even from ores containing iron as silicate.) If the ore contains silver, gold and platinum it is advisable to first extract the copper, nickel and silver, but care must be taken to add a sufficient quantity of sodium chloride to the washing solution to dissolve the silver chloride. If the ores or sands are fairly rich in gold or platinum it is sufficient to add some nitrate of soda or certain other nitrates to the chloride solution used for moistening the ore in the digester and to operate as explained before, making use of the combined action of silicic acid and steam under pressure. The "chlorides and nitrates are fairly well decomposed and gold and platinum are easily dissolved in the sort of aqua regia thus formed." For poor auriferous ores, it is better to use the cyanide process, using not potassium cyanide, but potassium ferrocyanide. The result of the combined action of silica, compressed steam and air is the formation of, firstly, a double silicate of potash and protoxide of iron, and, secondly, a double cyanide of potassium

and gold. The high temperature further aids the reaction. (915,705. March 16, 1909.)

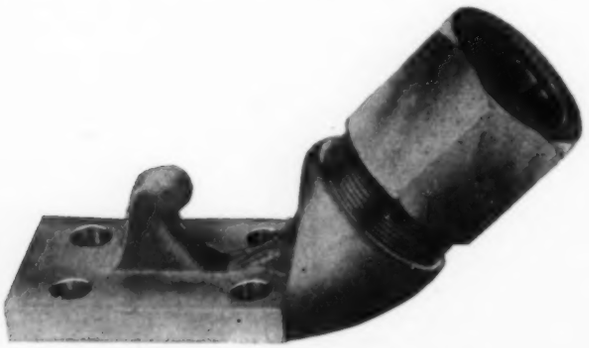
Silicon.

Calcium-Silicon.—In our June issue of last year (Vol. VI, p 244) Dr. Hans Goldschmidt discussed the use of calcium silicide for the purification of metals, especially steel. In this connection a recent patent of Dr. Goldschmidt is interesting as it describes a method of making an alloy of silicon and calcium free from carbon. Alloys of silicon with barium or strontium may also be made by this method. A mixture of two parts by weight of lime is mixed with one part by weight of silicon and with a suitable flux to produce a slag which crumbles. A convenient flux is fluoride of calcium which is mixed with chloride of calcium in the proportion of 15 parts of the former to 5 to 10 of the latter, and this mixture is added to 100 parts of the lime and silicon mixture. The mixture is heated in an electric furnace, yielding a calcium-silicon alloy of about 40 parts by weight of calcium and 60 parts by weight of silicon, if practically pure silicon is used. Instead of silicon, ferrosilicon may be used, and instead of lime, carbonate of lime or any salt of calcium which produces lime when being tested. The calcium-silicon alloy thus produced is free from carbon. As the slag crumbles on cooling, instead of forming a solid slag, the light grains of the alloy can be easily separated from the slag by screening. (915,172, March 16.)

Electric Furnace Leads.

An interesting phase of the development of the electric furnace is presented in the solution of the problem of making a good connection between the cables and the electrodes. Owing to the high temperatures prevalent in operation, soldered joints are out of the question.

Messrs. Dossert & Company, of New York City, have perfected a type of solderless connector which is admirably adapted to meet the exigencies of the electric furnace. The accompanying illustration shows a Dossert lug made for the equipment of the furnaces of the Susquehanna Smelting Company, of Lockport, N. Y.



ELECTRODE CONNECTION FOR FURNACE.

The cables are 2,000,000 circular mils, with a capacity of 36,000 amperes. The furnace leads enter the Dossert lugs by means of a compression sleeve held within a compression nut which screws up on the nipple end of the lug, clutching the cable with a tight grip and affording perfect contact. No solder is used, and, in addition to being exempt from the troubles incident to melting of soldered connections, the Dossert joint requires only a few minutes' time to be connected or disconnected at will without injury to either the connector or the cable.

The Use of Pyrometers in Various Industries.

An interesting little pamphlet in German on the use of pyrometers in various metallurgical and chemical industries has been issued by the Siemens & Halske Co. It discusses the adaptability of different types of pyrometers—thermoelectric, electric resistance and optical pyrometers—in different industries. While the pamphlet contains considerable details on pyrometer installations, we will give in the following abstract only the chief recommendations which are made in the pamphlet.

Blast Furnaces.—To measure the temperature of the blast, thermoelectric pyrometers with a platinum, platinum-rhodium couple are recommended. Since the temperature does not rise above 900° C., a platinum, platinum-iridium couple could be used, but a platinum, platinum-rhodium couple is preferable, since it can be made more reliable so as to remain accurate for a very long period of use. To protect the couple a double tube of fused quartz with iron tube and a cast-iron cooling head is recommended. It is important to take into consideration a possible variation of temperature of the "cold junction," but with the aid of the "cooling head" this variation of temperature can be reduced to a permissible minimum. The instrument, which gives the temperature, is preferably built as a recording instrument. If several thermocouples are connected to the same recorder, the automatic switch, described on page 135 of our last issue, is recommended.

Foundries.—While the skilled foundry foreman formerly relied on his eye to estimate the correct temperature of casting, the optical pyrometer is more reliable and cheaper, since less expensive help can be employed. The temperature of casting must, of course, be known. The incandescent lamp of the pyrometer is adjusted to this temperature and as soon as the observation of the molten metal surface shows that it has assumed the correct temperature, casting begins. The pyrometer is placed at a distance of about 2 m (6½ ft.).

Annealing and Hardening Furnaces.—In simple gas furnaces a thermo-electric pyrometer with indicating instrument is most convenient. In larger furnaces it may be important to determine the temperature of certain special pieces which are being heated. This can best be done by means of an optical pyrometer through a peep-hole in the door. For hardening furnaces (gas-fired muffle furnaces, fused lead bath, electrically fused barium chloride bath) the thermoelectric pyrometer is used with indicating instrument.

Tempering Furnaces.—Here again the thermo-electric pyrometer is most convenient. In case of a series of tempering furnaces five of them, with their thermocouples, are connected to one recording instrument with automatic switch.

Boilers.—To control the temperature of the flue gases, platinum, platinum-iridium couples with indicating or recording instrument are recommended. If for special reasons the temperature in a steam pipe is to be measured, a copper-constantan thermocouple (which can be used up to 500° C. or 932° Fahr.) is screwed into the pipe.

Porcelain Stoneware Factories.—In view of the large space of the furnaces the optical pyrometer is in general most suitable as it permits to determine easily the temperature at any desired place within the furnace. If a furnace is always charged with the same material, as is often the case in stoneware factories, a platinum, platinum-rhodium thermoelectric pyrometer with recording instrument is most useful. In this case a standard temperature curve, showing the variation of temperature during one firing operation, is plotted as the result of a number of successful runs and all following runs are adjusted according to this temperature curve.

Chemical Works.—In sulphuric-acid works the temperature in the lead chambers is best controlled by means of electric resistance pyrometers. A number of these are connected to an indicating instrument for use of the foreman, while a recording instrument is placed in the superintendent's office.

Glass Works.—In glass manufacture both thermo-electric and optical pyrometers are employed as follows: For the melting furnace the platinum, platinum-rhodium thermo-element with indicating or recording instrument; for determining the tempera-

ture of casting the optical pyrometer, and for the cooling furnace, the platinum, platinum-iridium thermo-element with indicating or recording instrument.

Further details concerning the pyrometers made by the Siemens & Halske Co. may be obtained from this company itself at 50 Church Street, New York City, or by their sole agent, Mr. Charles Engelhard, 32 Cortlandt Street, New York City.

Induction Furnaces.

While we have kept our readers fully informed of all advances in recent years in the construction, design and applications of electric induction furnaces, a concise summary of the present state of the design should be welcome.

Induction furnaces are now made in two distinct types: First, the simple induction furnace, as invented by Mr. E. A. Colby, of this country, and Dr. Kjellin, of Sweden, and second, the "combination furnace," a combination of the induction principle with electrodes, invented by Messrs. Roechling and Rodenhauser, of Germany. Both types of furnaces are built in this country by the American Electric Furnace Co., of New York City.

The simple induction furnace consists of an annular hearth lined with magnesite, through the center of which passes one leg of a transformer, around which the primary coil is placed. The primary coil is connected to the terminals of a single-phase alternator or transformer, and the alternating current in the primary induces a low-voltage high-amperage current in the annular hearth. The arrangement is equivalent to a transformer with a single secondary turn (the annular hearth). The amperes in the annular hearth are, therefore, approximately equal to the amperes in the primary circuit, multiplied by the number of primary turns.

The combination furnace consists of the same arrangement, but in addition has a number of steel-terminal plates embedded in the lining, which are connected to a few heavy turns of copper placed outside the primary coils, which collect and feed to the terminal plates the induced current in these turns. The

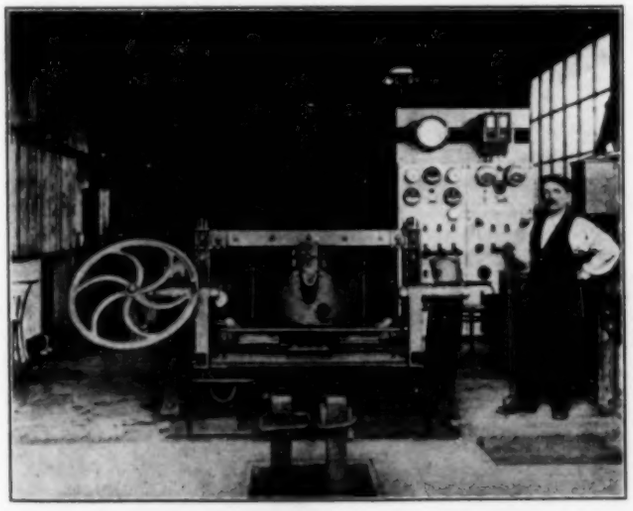


FIG. 1.—60-KW SIMPLE INDUCTION FURNACE FOR STEEL, BRASS, BRONZE OR ALLOYS.

close proximity to the primary coil and to the magnet core of these auxiliary turns tends to suppress magnetic leakage which, in a large, simple induction furnace may be very considerable. It follows, therefore, that for large-size simple induction furnaces an unusually low frequency must be used to avoid a poor power factor. Owing to the above-mentioned arrangement of secondary turns and terminal plates, the combination furnace can be built up to a large size and still work with currents of normal frequency and show a good power factor. A high primary voltage may be used, so that it is possible in most cases to use central-station power and avoid the expense of installing expensive generating plant.

The terminal plates, being protected by the lining which here acts as a "conductor of the second class," do not come in contact with the molten bath, and therefore can be used for an indefinite length of time.

The combination furnace can be run either on a single or

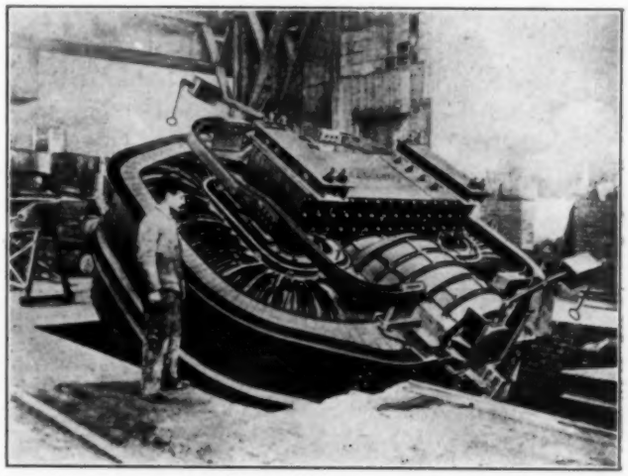


FIG. 2.—TILTING AN 8-TON COMBINATION FURNACE.

three-phase circuit, but as a general rule is built on the three-phase system, as a power plant for this class of current is less expensive to build asd easier to regulate, besides being more convenient for general power-distribution. Further details of the design of the Roechling-Rodenhauser combination furnace may be found in our Vol. VI, pages 10 and 458.

These two types of furnaces have each their own uses and advantages. The simple induction furnace is primarily a melting furnace and can be used to the best advantage in melting high-quality material which needs little or no refining. It is used commercially as a substitute for pot melting and produces extremely high-class steel. In one important direction it has a great advantage over the ordinary crucible, namely, that a high and easily controlled temperature is obtainable. Readings of 1700° to 1800° C have been obtained, and, as the temperature is directly dependent upon the primary current, it follows that the regulation is very simple.

Among other advantages of this type of furnace for melting steel is the economy in labor over ordinary pot melting. Three men and a boy per shift can easily handle a furnace capable of producing 1000 tons of tool steel per year.

The whole process is clean, the material to be melted is not affected in any way by the method of heating, no gas can injure the steel, and "overkilling" is practically impossible.

The combination furnace is intended for such cases where an efficient refining operation is required. It is constructed in such a way that slags are easily worked in a roomy and accessible central hearth. Hot metal taken from the converter, open-hearth furnace or gas-fired mixer can be treated, and a large daily output of highly refined material produced.

The finished product is made into rails, axle or tire blooms or tool steel in accordance with the degree of refining carried on.

In the case of the simple induction furnace the charge introduced into the furnace may be either in the hot molten state or in the form of cold scrap, pig iron, etc. As already explained, the action of the furnace depends upon a complete ring of metal being obtained in the hearth, and it is obvious that this result is most readily attained by pouring in molten metal which can flow round the annular hearth and complete the

ring. If the charge is added in this molten condition, naturally a saving is effected in time and power during the treatment in the furnace. However, in the simple induction furnace, it is more usual to charge with cold materials, and in this case it is necessary to have one or more metal rings in the hearth when starting up the furnace. The rings may be of cast or wrought iron, as most convenient, and the current is turned on until they melt down. The charge is gradually added and rapidly melts down until the required full charge is complete. The temperature is now raised to any desired degree, and the necessary additions made for correction of carbon, manganese, chrome, tungsten, etc., according to the class of steel to be produced.

The furnace, built on a tilting frame, is teemed into the ladle. Where cold materials are charged, about one-third of the total furnace contents is retained in the hearth, in order to secure continuous operation of the furnace.

Another use for this type of furnace has been found in melting and preparing brass and similar alloys. For this purpose a special crucible has been devised, the material of which

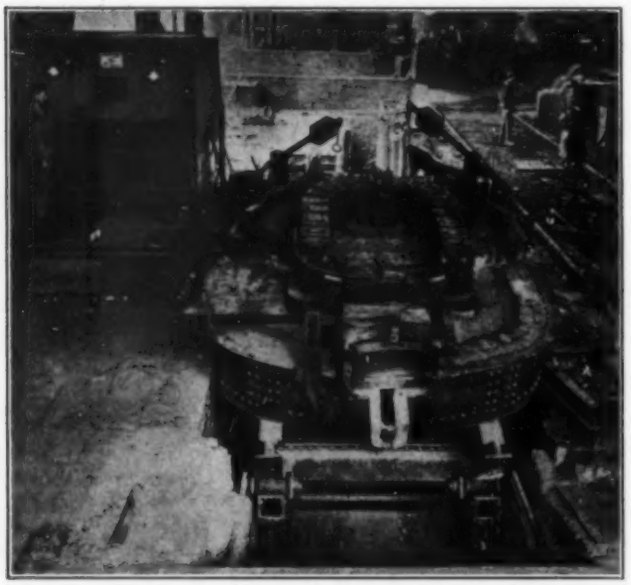


FIG. 3.—1-TON THREE-PHASE COMBINATION FURNACE.

is to some extent a conductor of the electric current. In this case, the primary coil is so arranged that the crucible can be heated directly up to the melting point of the metal, thus avoiding the necessity of starting up by means of an initial molten charge or cold rings.

Other advantages of this method are that the crucible can be thoroughly emptied at each melt, and recharged with cold metal, and that it is possible to shut down the plant entirely at night, without fear of damaging the lining.

Whereas the use of the plain induction furnace is thus necessarily confined to high-grade steels, brass and bronze, the combination furnace is particularly adapted for treating and producing steel in large quantities.

Under ordinary conditions the side channels, forming the induction part of the furnace, are very little affected by slag corrosion, being so arranged that no slag can enter this portion of the bath. Therefore, only the central part of the working hearth lining has to be renewed at intervals.

The terminal plates are covered with lining material stamped in a similar way.

The furnace is started up in the first instance in a manner similar to that used for the simple induction type, and hot metal is added as soon as the lining is burned in.

The lining consists of dolomite mixed with a proportion of coal tar, the whole forming a plastic mass, which is heated and stamped in by means of hot rammers.

The metallurgical reactions are similar to open-hearth practice.

The power consumption varies in direct proportion to the degree of refining considered desirable. It also depends to some extent upon the size of the furnace, as a large furnace loses less in radiation than a small one. As a general rule, it may be stated that the thermal efficiency varies from 55 per cent to 68 per cent.

In the following we give a list of the types and sizes of furnaces, as now built commercially, with interesting data on power consumption, frequency, power factor, etc., according to the claims of the manufacturers:

Contents in tons.	Maximum power in kw.	Power to keep furnace hot.	Power factor.	Periods.
0.1 to 0.15, simple induction...	60	25	0.76	60
0.5 to 0.75, combination.....	100	30	0.85	50
0.8, simple induction.....	150	40	0.70	25
1, combination.....	175	50	0.80	50
1.5, combination.....	275	80	0.70	50
1.6, simple induction	225	75	0.65	16
2.5, simple induction.....	350	310	0.58	14
3, combination.....	350	100	0.60	50
3 to 3.5, combination.....	350	100	0.80	25
5, combination.....	550	165	0.65	25
7, combination.....	700	210	0.60	25

The last mentioned biggest 7-ton combination furnace is claimed to produce daily 140 tons for rails and 63 tons for high-grade steels. If it is charged with molten converter steel, the latter containing 0.08 P., 0.08 S., 0.5 Mn., 0.1 C., the steel is refined in the electric furnace to steel for rails containing 0.05 P., 0.04 S., 0.8 Mn., 0.5 C., with a power consumption of 100 kw-hours per ton. The same converter steel is refined to high-quality steel containing only traces of P. and S. and 0.2 Mn., 0.5 C., with a power consumption of 250 kw-hours per ton.

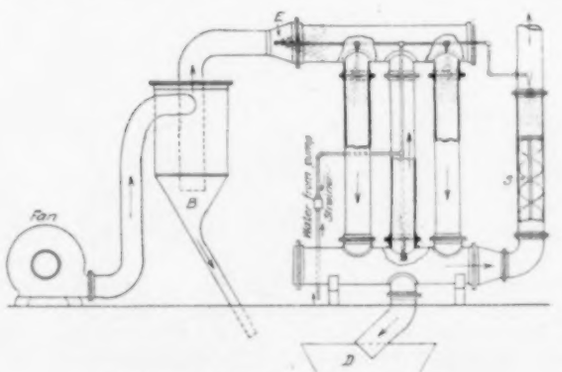
With the same electric furnace, when charged with molten open-hearth steel, the daily production is 70 tons.

The analysis of the electric steel rails made by the Roechlingsche Eisen und Stahlwerke for the Prussian State Railways is 0.75 C., 0.10 Si., 0.67 Mn., 0.044 S. and 0.023 P.

Collecting Precious Metal Dust.

Various means have been devised for collecting or reclaiming the precious metal dust in mills crushing and treating the ores dry, and the following application of the Koerting spray nozzle and dust collector will be found interesting in this connection.

The below illustration shows one of the exhaust fans ex-



COLLECTOR OF PRECIOUS METAL DUST.

hausting the dust from the mill and discharging the same through a pipe to the air separator *B*. The heavy metal discharge into this separator drops to the bottom and then spouts down to proper machine for treatment.

The separator *B* does its work quite satisfactorily, as far as

it goes, but does not take care of a large quantity of very valuable dust, which sometimes goes to waste for lack of the proper apparatus or method of reclaiming it. In quite a number of cases this dust contains some of the richest values in the ore and in some instances weighs as much as 135 lb. per cubic foot and contains from 20 to 30 per cent of the valuable metals.

The dust collector is made of suitable metal according to requirements, and is equipped with a sufficient number of spray nozzles of special construction through which water under about 50-lb. pressure is forced.

The ore dust is forced by the blower and enters at *E*, and in passing up and down the different compartments is absorbed by the water discharged through the spray nozzles containing a spiral, which imparts to the water a rotary motion. This has the effect that on issuing the water is torn into a very fine spray which completely fills the different dust-collector pipes in which nozzles are installed; therefore as the dust passes through the sprays it is thoroughly saturated with water, drops to the bottom of dust collector, and its deposition in sealed tank *D* is made certain.

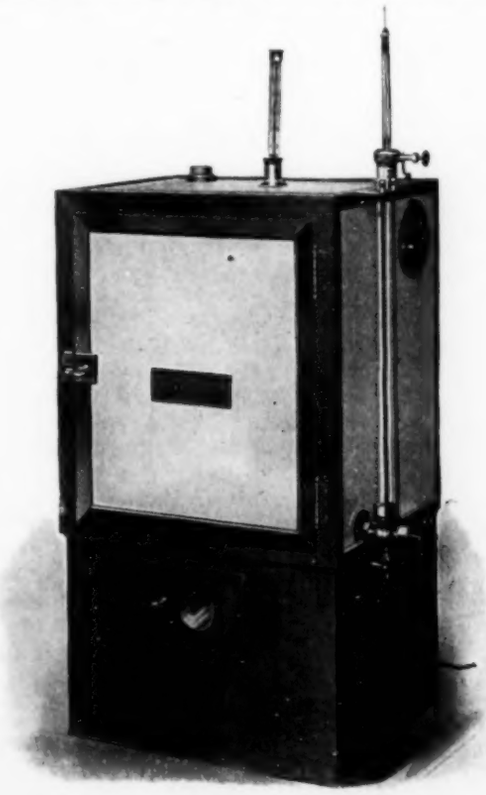
Of course, in the steel tank sufficient water is added to make a wet pulp so that it will easily run to the table vanner below.

To be absolutely sure that none of the valuable dust escapes with the surplus air at the air outlet *S* of dust collector, a sheet-iron spiral, as shown in the illustration, is installed, and above this spiral is also installed another spray nozzle.

The spray nozzles and dust collector referred to above are manufactured by the Schutte & Koerting Company, of Philadelphia, Pa.

Electrically Heated Incubator for Laboratories.

There is probably no place in scientific work where as fine an adjustment of heat is required as in the bacteriological in-



ELECTRICALLY HEATED INCUBATOR.

cubator and the work has been carried on for a long time under difficulties with the old-style gas-heated ovens.

The problem has been solved by using electricity for both the heating and the regulation, by the Scientific Materials Company, of Pittsburgh, Pa., and the oven, developed and patented by this company, is an interesting example of the possibilities of controlling electrically generated heat with utmost exactness.

The incubator consists of a three-wall oven, made of heavy copper, which provides a water jacket and an air space entirely surrounding the oven, and is thoroughly insulated with heavy asbestos board, which is finished in white enamel.

The desired temperature (37 2/5 deg. C.) is maintained by means of incandescent lamps in the base, which are controlled by a make-and-break device which is in turn operated by a new mercury regulator. By this arrangement the temperature can be maintained within a small fraction of 1 deg.; in fact, a 45-days' continuous test, made by Prof. H. E. Lowe, of the Carnegie Technical Schools, showed that the variation of temperature in this time was hardly perceptible.

Another feature of the apparatus is that it does away with the open flame, heretofore used for heating, thus eliminating the great liability of fire, as the operation is continued without interruption night and day.

In the water laboratories, an incubator is required which will maintain a constant temperature of 20 deg. C. and the electric incubator is answering this purpose admirably at the water purification plant of the city of McKeesport, Pa., where it is set up in an ice-box, wherein the temperature is kept below this point.

After experiments covering more than four years the inventors have a most simple and durable arrangement, which can be adjusted by the operator and can be used on any ordinary lighting circuit, either alternating or direct.

Washing and Coking of Coals.

Investigations conducted at the fuel-testing plant of the United States Geological Survey at Denver, Col., during the fiscal year 1908 into the washing and coking of the coals of the Rocky Mountain region have just been reported upon by the Survey.

Of 37 coals tested from the Rocky Mountain region all but three produced good coke under proper treatment, though a number of them had been considered non-coking.

A bulletin detailing the tests conducted at the Denver plant by A. W. Belden, G. R. Delamater and J. W. Groves has just been issued by the technologic branch of the Geological Survey. In this bulletin the following general statement is made by Mr. Belden:

"The washing tests of coal were made to determine the possibility of so improving the quality of the coal as to render it available for the production of coke—for the coal used in coking must be as free as possible from ash, sulphur and other impurities, because of its prospective use in metallurgical processes. The coking tests were made to determine the possibility of utilizing the various coals in this way or to devise improvements in coking practice. The washing tests have already demonstrated the fact that many coals which are too high in ash and sulphur for economical use under the steam boiler or for coking may be rendered of commercial value by proper treatment in the washery. The coking tests have demonstrated that many coals which were not supposed to be of economical value for coking purposes may be rendered so by proper treatment in the washery and coke oven. Of more than 100 coals from the Missisippi Valley and the Eastern States some of them regarded as non-coking, which had been tested at St. Louis in 1906 all except six had been found, when carefully manipulated, to make fairly good coke for foundry and other metallurgical purposes, and similar results with Western coals have been now obtained at Denver. The tests detailed in this bulletin are a continuation of the work started several years ago in St. Louis at the government fuel-testing plant there."

One-Half Ton Hoist.

The new type S-7 ½-ton hoist of the Sprague Electric Co., of New York City, is designed for lifting any kind of load and though it is rather inexpensive there is nothing cheap about it in construction.

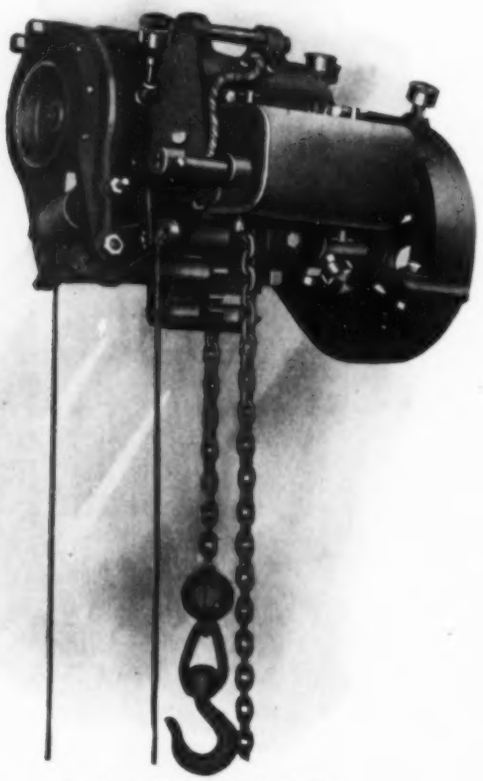


FIG. 1.—ONE-HALF TON HOIST.

Without load it weighs 230 lb., and it is 25½ in. high, 21 in. wide and 18½ in. thick.

The motor is wound for 115, 230 or 500 volts, direct current, is fully enclosed and dust and weatherproof.

The load is lifted by a chain and pocket wheel, the speed reduction for the pocket wheel consisting of a double reduction train of spur gears protected by casings. The gears are cut from solid blanks and all lubrication is by grease fed through compression cups.

Grease lubrication is in every way superior to oil for lubri-

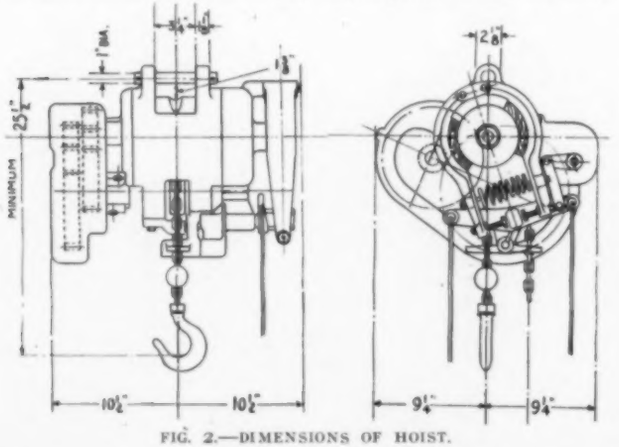


FIG. 2.—DIMENSIONS OF HOIST.

cating electric hoists. It is cleaner, does not drip and there is no danger of its getting into the armature or commutator.

The price of the S-7 hoist is low enough to permit of its installation over individual tools in the machine shop, or its general use in artificial ice plants and industrial establishments where the erection of a comprehensive runway system is impossible, either on account of first cost or because the buildings are not strong enough to support a long runway. In such cases light jibs can be placed at points where the loads are stored, the hoist and carriage running back and forward on the boom. These jibs are very inexpensive and can be attached to a building column if it is available or supplied with a mast, making them entirely independent of the building for support.

In small power stations and boiler rooms they are extremely convenient to aid in the disposal of ashes and in carrying coal to the furnaces, and in shipping rooms they can be used to load trucks with light packages, greatly economizing labor.

The amount of headroom taken up compares very favorably with a chain block of equivalent capacity, for which it may be substituted, thereby making a large saving in labor charges. The hoisting speed of the electric hoist is many times greater than the fastest speed possible with a chain block.

Cut No. 1 shows the appearance of this device, and on cut No. 2 are marked the overall dimensions.

Increase In Use of Wood Preservatives.

An increase from 3,500,000 gal. of the oil of coal tar, or creosote, imported into the City of New York in 1904, to an amount estimated to be almost 25,000,000 gal. last year, is one of the indications pointing to the progress of the movement for the conservation of forest resources.

It is creosote which the government and scores of corporations and private wood users have found to be one of the most satisfactory preservatives of railroad ties, mine props, telephone and telegraph poles, fence posts, and for timbers used for other commercial purposes.

Formerly the production of creosote, from both coal tar and wood tar, far exceeded any demand for wood-treating purposes. However, the number of wood-preserving plants has grown so rapidly within the last four years that this country is not now able to supply its own demand for coal-tar creosote.

This year has started most auspiciously; during a five-weeks' period in December and January the importation through New York alone was 15,000 tons, giving a weekly average of 3000 tons, or 68,000 gal. It is significant that during this same period the importation of related by-products from coal kept pace with that of creosote. Ammonium carbonate, chloride, sulphate and sal ammoniac entered to the amount of 104, 227, 1260 and 400 tons, respectively. If these had been all made into the sulphate, the equivalent product would have been 460 tons per week. The estimated ratio of 20 lb. of sulphate to 1½ gal. of creosote oil would make an equivalent production of 69,000 gal. of creosote. This is not far different from the 68,000 gal. which were really imported. Since these ammonia products and creosote are being imported in this relation, it is plainly evident that the production of creosote is not alone deficient, but also coal-tar products in general.

The production of creosote in this country will, in all probability, continue to be far less than the consumption. The wood preservation industry has been in its infancy only, and enormous demands may be expected in the future. The coke, and consequently the coal-tar industries, have until recently been at their best, but even at their best the supply of by-products has run short. On this account we should turn to the other sources to supply the increasing demands for creosote preservatives.

A great help may be eventually afforded by the increasing use of wood-tar creosote, which has not been in high favor in the past. Within the last few years some of the more important wood distillers have been turning into a profit those oils and tars which were formerly run to waste. The demand for these products is increasing, and this recovered by-product has been asserted to be not only a revenue for the producer, but also a valuable preservative for the treatment of structural timber.

Engineering Books in Public Libraries.

The more progressive city libraries of the country are paying increased attention to engineering and technical subjects in their work with the public. Among those which are especially active in this field is the Public Library of Washington, D. C., as shown by the annual report for 1907-08, just issued. This institution has organized a special department, the Useful Arts Department, to meet the demands of its readers for books on the engineering branches, trades and handicrafts, business and industries in general. Here on open shelves are placed about 6000 well-selected volumes, purchased very largely within the last three years and many of them expensive. Over 160 periodicals are received, which include nearly all the important American publications and some foreign. On the subject of electricity alone, for example, 12 periodicals are received.

All these periodicals, both current and back numbers, are freely accessible. All but current numbers are issued for home use. Various engineering indexes make their contents accessible.

An important feature of the room is the collection of trade catalogs issued by manufacturers. These catalogs are classified and arranged by subjects on open shelves and are indexed by firms. This feature, according to the report, is much appreciated by patrons of the room. Manufacturers and others in distributing advertising literature would do well to keep this library in mind.

Notes.

The University of Missouri, School of Mines and Metallurgy, Rolla, Mo., announces a six-weeks' summer school, beginning June 14, 1909, for mining students, mine managers and superintendents, graduates and undergraduates of engineering schools, etc. The courses include fire assaying, qualitative chemical analysis, quantitative chemical analysis, mineralogy, metallurgical laboratory work and a course in mining.

The **Wisconsin Section** of the American Electrochemical Society held a meeting on March 1 in the Chemical Engineering Building of the University of Wisconsin. Dr. O. P. Watts presented a paper on "The Improved Quality of Electrolytically Deposited Metals Caused by the Addition of Certain Foreign Substances to the Electrolyte." In the discussion which followed the paper, the influence of a concentrated film of non-conducting colloid or other inert foreign substance at the surface of the cathode was considered.

Nitric Acid from the Atmosphere.—The Gesellschaft für Sauerstoff und Stickstoff Industrie (German Society for the Oxygen and Nitrogen Industries, secretary, J. W. Haeussler, Berlin, W. 62 Kurfürstenstr 89) held a meeting on Feb. 19 in the Institute of Technology at Charlottenburg. Regierungsrat Kolbe was in the chair, and Professor Erdmann lectured on the fixation of atmospheric nitrogen in its technical and industrial aspects.

The **Ore Dressing Machinery Co.,** 114 Liberty Street, New York City, has just issued a well-illustrated pamphlet on the Hennig ore concentrator which we described in our January issue, page 42.

Messrs. **C. W. Leavitt & Co.** have removed their offices to the Hudson Terminal (Cortlandt Building), 30 Church Street, New York City.

Thermit.—The Goldschmidt Thermit Co., of New York City, has issued a revised and enlarged edition of their "Instructions for the Use of Thermit in Railroad Shops," giving concise and exact rules on the application of the thermit process for repairs of steel castings. Besides much useful technical information, the pamphlet contains many interesting and instructive illustrations.

Silico-Manganese.—We have received a report by Mr. A. Campion, analytical and consulting chemist, of Glasgow, on the use of silico-manganese as a substitute for ferrosilicon. In view of some accidents which recently occurred as a result of ferrosilicon shipped on board ship giving off poisonous gases, it is pointed out that silico-manganese is absolutely harmless under similar conditions. It can be stored or shipped without fear of explosion or poisoning, as it gives off no noxious gases. The use of silico-manganese instead of the combined use of corresponding quantities of ferrosilicon and ferromanganese has also certain advantages in the steel industry. Messrs. Roberts, Evans & Woodhead, of Liverpool, England, are the manufacturers of silico-manganese.

Electroplating and Storage Batteries.—The (London) *Electrician* of March 12 contains the following note: "It has been realized for some time past in the electroplating industry that the quality of the work is dependent upon steadiness of the electric current, the slightest variation affecting the density and evenness of the deposit. The D. P. Battery Co., of Bakewell, has recently laid down a battery with unusually large-size cells for a Midland firm. This has effected so marked an improvement in their manufacture that there seems little doubt that the use of accumulators, instead of plating direct from the dynamo, will ultimately become more or less general."

Perforated Metal.—The bulletin No. 1425, issued by the Allis-Chalmers Co., under the title "Perforated Metal," contains illustrations showing some of the varieties of perforated plates now commercially available. Perforated metal is considered to be superior to wire cloth in being much stronger, more uniform in size of hole or mesh and less liable to tear or rust out. Unlike wire cloth, it presents a perfectly smooth surface, allowing the material to pass it smoothly and quickly. It is not as liable to become clogged, making it more satisfactory for sizing, graining and separating. The Allis-Chalmers Co. rolls plates to exact diameter of cylinder and makes cylinders to order as well as revolving screens for stone, grain, coal, etc

Producer Gas from Peat.—According to the *Chemical Trade Journal* of Jan. 23, the Power-Gas Corporation, Ltd., who are exploiting Dr. Mond's patents in England, have been experimenting for many years past to apply the Mond process to the gasification of peat, and that success has marked their endeavors is shown by the fact that three installations are either already in operation or nearly completed—one in Norfolk, one in Italy, the third one at Mont Cenis Colliery in Westphalia, Germany—and it is expected that data as to regular running results will be published shortly. In the last-mentioned plant large practical trials of peat have been carried out by the officials of the Power-Gas Corporation, the following results having been obtained: The peat used in these trials contained from 40 to 60 per cent moisture, and from each ton of peat calculated as theoretically dry (containing 1 per cent nitrogen) there was produced 32 kilos. of sulphate of ammonia together with 2400 cu. m. of good power-gas, and, generally speaking, the results of this process are that 70 to 75 per cent of the nitrogen in the peat is recovered in the form of sulphate of ammonia together with 80,000 to 85,000 cu. ft. of good power-gas (150 B.t.u. per cubic foot) per ton of dry peat gasified. Messrs. Frank & Caro, of calcium cyanamide fame, are connected as consulting chemists with the German Mond Gas Co.

Tellurides.—Because some of the best gold ores of America are tellurides, a recent publication of the University of Wisconsin, entitled "A Study of Tellurides," by Dr. Charles Austin Tibbals, Jr., is of particular interest. Mr. Tibbals received the degree of Ph.D. at the University of Wisconsin in 1908 and is now assistant professor of chemistry at the Armour Institute of Technology, in Chicago. He has made a thorough study of the general field of artificial tellurides. His work forms a part of the detailed study of tellurium carried on at the University of Wisconsin under Prof. Victor Lenher for the past 11 years on the chemistry of telluride ores.

Gas Engines is the title of Bulletin No. 1063, issued by the Allis-Chalmers Company, which is the largest builder of gas engines in the world and has equipped some of the largest gas-engine plants now in operation. This bulletin was issued

for the express purpose of exploiting the vast fields of power service to gas engines and the economies afforded by their utilization of either producer gas, natural gas, or blast-furnace or coke-oven gas. Although natural gas and furnace gas are not always available, producer gas can be made from almost anything that will burn and such coals as lignite, slack and bone, that cannot be used under boilers in the production of steam, have been profitably utilized in a gas producer and gas engine. Lignite beds underlying from 20,000,000 to 30,000,000 acres of public land, heretofore supposed to be practically useless, are now shown to have a large value for power development. As fuel is ordinarily used for light, heat and power, the losses are so great that, of the total calorific value of the coal, less than 5 per cent on an average is converted into useful work, while the largest and best power stations utilize only about 10 per cent. With the gas-engine-driven units, however, fuel economy is the distinguishing characteristic, resulting in a delivery at the engine shaft of not less than 16 to 20 per cent of the energy contained in the fuel.

Copper Ore.—The well-known firm of ore and metal shippers, the Société Maritime & Commerciale, Antwerp, Belgium, have appointed C. W. Leavitt & Co., New York, as their selling agents in America for their iron and copper pyrites, copper precipitate, copper matte, manganese ore, etc.

European Zinc Trust.—According to a recent consular report an international agreement has been concluded between a number of prominent zinc works, resulting in the organization of what is designated as the "Syndicate des Usines à Zinc." The limit of production of each one of the firms having been established, the principal clause of the agreement stipulates that should the current price of zinc fall below £19 ($92.46), or should the accumulation of stocks show an unusual increase, the limit of production will be proportionately reduced. If, on the other hand, the current price of zinc continues to be above £19, this limit of production may be increased as arranged in virtue of an agreement between delegates from each group of concerns making up the trust, which includes German, Belgian and English concerns, although it seems that agreements have not yet been concluded with the last mentioned. It is asserted that the Giesche works, which produce one-fifth of the total output of zinc in Silesia, is not included in the new combine, whose main object is to regulate production, but competition from this quarter apparently is not feared. Steps have been taken to induce the five most important zinc works in England to join the trust; as to the zinc works of the United States, it is believed that anything like extensive exports of zinc from that part of the world are too far in the future to meet serious consideration at the present time. It is rumored that one of the earliest results of the formation of this trust will be an increase in the present price of zinc, such an advance having already been definitely decided upon. It is further reported that the organization of the syndicate composed mainly of German zinc manufacturers was concluded the latter part of February under the form of a limited liability company. The capital is said to be $509,400, and the management is placed in the hands of Director-General Lob, of the Hohenlohe Works. The sale of zinc will be effected through the agency of Beer, Sonheimer & Co., the Metall Gesellschaft of Frankfort-on-the-Main, and by Aron Hirsch, of Halberstadt. It is stated that this new combine also includes a large number of Belgian, French, Dutch and Austrian works.

Digest of U. S. Patents

Compiled by Byrnes & Townsend, Patent Lawyers, National Union Building, Washington, D. C.

ELECTRIC FURNACES (*Continued*).

No. 587,182, July 27, 1897, Guillaume De Chalmot, of Leaksville, N. C.

Arc type. A cast-iron pot mounted on wheels serves as one electrode, receiving a depending carbon electrode. The pot may be lined, or the refractory charge may afford sufficient protection. A layer of carbon is placed in the bottom in starting. The pot may be lined with fire brick and then with carbon, or directly with carbon. The sides and bottom may be in different sections and of different materials. The pot is reciprocated, rotated, or otherwise shaken or jarred, to feed the charge into the arc and beneath the depending electrode. "With an ordinary arc-furnace only the outer margin of the area of the arc is fully effective, since the material to be reduced cannot be introduced beneath the pencil far enough to completely fill the arc, but will only fall in so far as corresponds to its natural or characteristic slope." "The most effective utilization of an arc in electric smelting is only to be attained by filling the entire area in which the arc exists with the material to be smelted and feeding this material in throughout this area as fast as the previously introduced material becomes fused and reduced or fully smelted." The pot may be reciprocated from two to four inches on a track, from five to thirty times a minute, shaking the material down, spreading it out to a considerable distance beneath the lower end of the pencil, and effecting a more thorough distribution of the material to be smelted over the area of the arc. The reciprocation may be effected by a conducting bar connected at one end to the pot by a pin and clamp and at the other end to a pitman. The bar may be connected to one of the electric mains by a flexible cable or zigzag plate.

The bar may advantageously consist of a plate of copper and plate of iron. The holder for the upper carbon has a dovetail groove receiving the upper ends of a number of adjacent carbon slabs which taper downward, removable iron strips extending between the holder and the carbon ends. The holder is carried by an adjustable bar consisting of a strip of copper and two outer strips of iron, being dovetailed at its lower end into the carbon-holder. The pot may be shaken by mounting it on an oscillating shaft either central or eccentric, or it may be mounted to turn on a horizontal axis.

No. 588,267, Aug. 17, 1897, Guillaume De Chalmot, of Leaksville, N. C.

Arc type. This furnace, which is especially designed for treating phosphate rock, consists of a brick structure which may be lined with carbon. The hearth of the smelting chamber is a horizontal iron plate, covered with carbon and serving as one electrode. The other electrode is a depending carbon block built up of slabs or square bars, adjustable through a hole in the roof. It may be enclosed by an iron casing above the roof, to exclude air. At one side of the furnace-chamber is an outlet, through which the molten product may overflow. A flue leads from the other side over trays to a stack. A stream of heated air may be supplied to the outgoing fumes. The molten phosphate rock flows continuously from the furnace onto a horizontal iron drum, which is hollow and may be cooled by radiation, currents of air, or by playing water on it by a hose. Sand is sprinkled onto both the descending and ascending sides of the cylinder, the molten phosphate thus flowing onto a coating of sand and being subsequently sprinkled with sand. Sand may be fed into the furnace with the ground or broken rock, and sand may be fed onto the receiving cylinder together with the molten phosphate. Beneath the cylinder is a tank containing water to receive the solidified phosphate. The tank is pivoted to dump the material onto a grating beneath. The wall of the furnace containing the overflow-passage may be built of phosphate rock, and the position of the opening may be varied in height by increasing or decreasing the temperature in the furnace-chamber, thus partly melting away the wall or, reversely, allowing it to build up by solidified product. The fumes from the furnace chamber may be carried over crushed phosphate rock, lime, or water, placed in the trays, to take up the anhydrous phosphoric acid. The air entering the flue oxydizes the fumes.

NEW BOOKS.

Heat Energy and Fuels: Pyrometry, Combustion, Analysis of Fuels and Manufacture of Charcoal, Coke and Fuel Gases. By Hanns v. Jüptner. Translated by Oskar Nagel, N. Y. 311 pages. Bound in cloth. Price, $3 net. New York: McGraw Publishing Co.

First Principles of Chemical Theory. By Champion Herbert Mathewson. 130 pages. Bound in cloth. Price, $1. New York: John Wiley & Sons.

The Principles of Inorganic Chemistry. By Wilhelm Ostwald. Translated by Alexander Findlay. 833 pages. Bound in cloth. Price, $5 net. New York: Macmillan Co.

The Theory of Valency. By J. Newton Friend. (Text books of physical chemistry; edited by Sir W. Ramsay.) 194 pages. Bound in cloth. Price, $1.60. New York: Longmans, Green & Co.

An Intermediate Course of Laboratory Work in Chemistry. By J. Wallis Dodgson and E. Kenneth Hanson. 130 pages. Bound in cloth. Price, $1.20 net. New York: Longmans, Green & Co.

A Shorthand Book of Oil Analysis. By A. Herman Gill. 179 pages. Bound in cloth. Price, $2 net. Philadelphia: Lippincott.

Examination of Water for Sanitary and Technical Purposes, by Chemical and Bacteriological Methods. By H. Leffman. 144 pages; illustrated. Bound in cloth. Price, $1.25. Philadelphia: P. Blakiston's Sons & Co.

The Dyeing and Cleaning of Textile Fabrics. A handbook for the amateur and the professional. By F. A. Owen, based partly on notes of H. C. Standage. 259 pages. Bound in cloth. Price, $2. New York: John Wiley & Sons.

Clays: Their Occurrences, Properties and Uses; With Special Reperence to Those of the United States. By Heinrich Ries. 573 pages. Bound in cloth. Price, $5 net. New York: John Wiley & Sons.

Refrigeration; a Practical Treatise on the Scientific Principles, Mechanical Operation and Management of Refrigerating Plants Based on the Various Modern Systems of Artificial Cooling. By Francis Howard Boyer and C. Dickerman. 109 pages. Bound in cloth. Price, $1. Chicago: American School of Correspondence.

Forging; a Manual of Practical Instruction in the Hammering, Working, Forming and Tempering of Wrought Iron, Machine Steel and Tool Steel, Including Details of the Modern Process of Electric Welding. By J. Lord Bacon. 112 pages. Bound in cloth. Price, $1. Chicago: American School of Correspondence.

Sheet-Metal Work; a Manual of Practical Self-Instruction in the Art of Pattern Drafting and Construction Work in Light- and Heavy-Gague Metal, Including Skylights and Roofing, Cornice Work, Etc. By W. Neubecker. 267 pages. Bound in cloth. Price, $3. Chicago: American School of Correspondence.

Compressed Air: Its Production, Uses and Applications; Comprising the Physical Properties of Air From a Vacuum to Its Highest Pressure, Its Thermodynamics, Compression, Transmission and Uses as a Motive Power. Very fully illustrated, including 44 air tables. By Gardner Dexter Hiscox. 694 pages. Bound in cloth. Price, $5. New York: Norman W. Henley Publishing Co.

Steam Boilers. Part 1: Construction of Boilers; Part 2: Types of Boilers. By Carl Stephen Dow and W. S. Newell. 141 pages. Bound in cloth. Price, $1. Chicago: American School of Correspondence.

The Boiler; Boiler Rules and Tables Used in the Construction, Testing and Operation of Steam Boilers, Rules Comprehensive and Exemplified. By Stephen Christie, 264 pages. Bound in cloth. Price reduced from $2.50 to $1.75. Chicago: Christie Publishing Co.

Vectors and Vector Diagrams, Applied to the Alternating-Current Circuit, With Examples of Their Use in the Theory of Transformers and of Single and Polyphase Motors, Etc.; With Diagrams. By C. F. Smith and Walter Cramp. 268 pages. Bound in cloth. Price, $2.50 net. New York: Longmans, Green & Co.

The Old Cannon Foundry Above Georgetown, D. C., and Its First Owner, Henry Foxall; Reprinted from the Records of the Columbia Historical Society. By Madison Davis. 55 pages. Paper binding. Lancaster, Pa.: New Era Printing Co.

BOOK REVIEWS.

Alloys and Their Industrial Applications. Edward F. Law, Associate Royal School of Mines, London. 8 vo., 268 pages, 57 cuts, 42 microphotographs. Price, $4. Philadelphia: J. B. Lippincott Company. London: Charles Griffin & Company, Ltd.

We are pleased to welcome another good book on alloys; that is, a book not of the cook-book recipe order, but an intelligent, scientific discussion of a field where the light is at present breaking fast. Furthermore, the treatise is altogether modern in its spirit; each chapter has at its close a bibliography; it is, moreover, full of bright observations and useful suggestions. One of the best innovations is the adoption of 100 and 1000 diameters as standard magnifications, so that, the enlargement being aways the same, the mind may easily and instinctively compare the size of grain, constituents, flaws, etc. We heartily second the recommendation that these powers be adhered to wherever they are suitable for the alloy in hand.

We know of no book on alloys giving a more readable, exact and intelligent review of the subject; it is particularly recommended to students and technically trained persons wishing enlightenment in this difficult, yet fascinating, metallurgical field.

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The Chemistry and Literature of Beryllium. By Charles Lathrop Parsons, professor of inorganic chemistry in New Hampshire College. 180 pages. Price, $2. Easton, Pa.: The Chemical Publishing Co.

This is an excellent monograph on beryllium, written by the well-known secretary of the American Chemical Society.

"The book is written with the main object in view of saving preliminary study and labor to future investigators of beryllium and to point out some of the peculiarities of this interesting element which are apt to lead the novitiate toward erroneous conclusions. Especially it is desired to call attention to the fact that a large proportion of its accredited compounds are in reality but indefinite solid solutions. This condition of the literature beryllium is due to the abnormal salts, giving rise to solids of almost any degree of basicity or to solutions with decreased osmotic effects. Accordingly, results of analysis, freezing points, etc., give little evidence of the true nature of its compounds, unless accompanied by proved definiteness of composition, a proof too often omitted throughout the whole field of inorganic chemistry, but nowhere more than in studying beryllium and its compounds."

The first part (71 pages) contains chapters on metallic beryllium, normal compounds of beryllium, acid salts of beryllium, double salts of berryllium and basic salts of beryllium. The second part is a very valuable bibliography, with concise, yet rather full abstracts of all original papers and articles on beryllium, and references to abstracts of such papers. An authors' index and a subject index concludes the book.

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Organic Chemistry. Including portions of Physical Chemistry. For Medical, Pharmaceutical, and Biological Students. (With Practical Exercises.) By H. D. Haskins, A. B., M. D., and J. J. R. Macleod, M. B., D. P. H. First Edition. Price, $2 net. New York: John Wiley & Sons.

To write a short text book and impart to the student a sci-

ence or portion of a science based on theories, in a brief, simple, consistent and logical manner, is no easy matter. Professors Haskins and Macleod, in their book on Organic Chemistry for Medical Students, have in 367 pages shown that they are talented in imparting their knowledge and that they fully appreciate the value of the knowledge of this branch of science for the medical, pharmaceutical and biological student.

The authors have clearly applied the existing theory to physiological reactions. The application of physicochemical laws in explaining the mode of action of the commonly used organic compounds not only demonstrates the importance of a knowledge of physical chemistry to the medical student, but also makes the text book extremely interesting. It does not make organic chemistry a compilation of a lot of dry facts, as most students consider it, but it increases its value in the student's eye, makes it more interesting study, and gives him initiative to reason out the many physiochemical actions which take place in the human system.

In the majority of cases the reactions of the organic compounds are explained, which take place when organic compounds pass through the human system. Also in several cases the authors give the occurrence of certain compounds present in drugs, explaining thereby their chemical reactions in the human system.

The authors fully realize that the most important of recent advances in medical science are those relating to the chemistry of the various organic substances which enter into composition of animal tissues and fluids, and to the physicochemical laws which govern and influence most physiological processes. Thus, for instance, the discovery of the constitution of the purin bodies, of most of the urinary constituents, of sugars and fats, etc., has demonstrated the importance of organic and physical chemistry to the medical, pharmaceutical and biological student. A striking illustration of the importance of these branches of chemistry is the recent application by Arrhenius of certain physicochemical laws in explaining the mode of action of antitoxins.

Considerable attention is given in the first portion of the book to a description of methods employed for purifying and testing the purity of substances. A full chapter gives the principles of physical chemistry as applied to molecular weight determinations and the theories of osmosis, solution, etc., while special facts of physical chemistry are inserted where they can most conveniently be studied along with organic compounds. In describing the various groups of organic substances there is chosen as the representative of each group, where possible, a compound of medical or biological importance.

The practical exercises in the book embody the idea of accuracy and tend to give the student a grasp and clear understanding of the subject of organic chemistry.

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Synthetic Perfumes and Flavors. A lecture delivered at Columbia University. By Alois von Isakovics. 29 pages. Monticello, N. Y.: Synfleur Scientific Laboratories.

This lecture was delivered by invitation last year at Columbia University, College of Pharmacy, Department of Chemistry. The object is "to cover the subject as briefly as possible, selecting representative examples of the formation of various bodies which find extensive application. We to-day manufacture commercially in the laboratory about 150 distinct perfumery and flavoring products, all raw materials for the use of the manufacturing industry, most of which materials must be composed of a number of constituents in order to be available for commercial application and to give the true natural flower odor or fruit aroma."

The lecture is most fascinating reading. It conveys a pleasure, always felt when an author is not only master of his subject, but is able to present it in a lucid and interesting manner; and synthetic perfumes and flavors form a chapter of organic chemistry which is in itself of peculiar interest.

Theory and Calculation of Transient Electric Phenomena and Oscillations. By Charles Proteus Steinmetz. 581 pages; 102 illustrations. Price, $5. New York: McGraw Publishing Co.

This book represents the results of a number of years of work by the distinguished author, and is undoubtedly his most important contribution to the science of electrical engineering.

The introduction treats the electric circuit, explaining in words the inter-relations of the various factors of electric, magnetic and electrostatic energy, and defining the various phenomena and constants of electric, magnetic and electrostatic circuits, which are of universal importance.

Section I is devoted to transient phenomena in time, which heading includes the treatment of the phenomena occurring in both direct-current and alternating-current circuits when subjected to sudden instantaneous charges in current or e.m.f.

Section II is entitled "Periodic Transient Phenomena" and treats the phenomena in circuits which are periodically interrupted or reversed.

Section III treats of transient phenomena in space. Although the whole book is more or less pioneer work, this is especially true of the third and fourth sections. This section treats the distribution of waves in long transmission lines, the distribution of alternating flux in magnetic circuits, the distribution of alternating current in electric conductors, and the velocity of propagation of the electrical field. The data and discussion given here should be useful to those working with long-distance transmission lines for power, long-distance telephony, and wireless transmission.

Section IV combines sections I and III, treating transient phenomena in both time and space. This section is the masterpiece of Dr. Steinmetz. In it he has developed general equations for the energy factors of electric circuits, which take into account both time and space phase displacement. From the general equations are treated: Standing waves, traveling waves, free oscillations, phenomena occurring at transmission points in the line, and inductive discharges.

The treatment throughout is clear and concise, and the physics is well explained. Each subject is first discussed in words, then developed mathematically, the results discussed and the conclusions drawn. The engineer on the firing line will be chiefly interested in the statement of the problems and the results, while the entire development can be worked through by the student. All those interested in long-distance transmission lines, extensive underground distribution systems, long-distance telephony, regulation of machines, wireless transmission, lightning phenomena, surges, etc., will find here the first real treatment of the theory involved.

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Social Engineering. By William H. Tolman, Ph.D. With an introduction by Andrew Carnegie. 384 pages, 43 illustrations. Price, $2. New York: McGraw Publishing Co.

In the brief introduction, Mr. Carnegie maintains that socialism talks speculatively, while individuals work practically, curing evils that socialists point out. "This is the right division between the individualist and the socialist." The thought is loosely expressed, but is worth thinking out to its logical conclusions.

Dr. Tolman "points out," and in so far is a typical socialist according to Mr. Carnegie's dictum, but we know that in practice he also performs and cures; he is, therefore, also a typical individualist. He discusses his topics in the following order: "Promotion of Efficiency of Employees," "The Social Secretary," "Hygiene," "Safety and Security," "Mutuality," "Thrift," "Profit Sharing," "Housing," "Education," "Recreation," "Social Betterment," and "Does It Pay?"

If there is an electrochemist or metallurgist who is not either an employer or an employee, such may possibly have no use for this book; all others are recommended to "read, mark, learn and inwardly digest" its highly useful contents.